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# CHEMICAL, BIOLOGICAL AND RADIOLOGICAL (CBR) OPERATIONS

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No. 3–5

HEADQUARTERS,
DEPARTMENT OF THE ARMY
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# CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL (CBR) OPERATIONS


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*** This manual supersedes FM 3–5, 5 November 1958, including C 1, 17 May 1960; and FM 3–9, 1 April 1955.**

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# CHAPTER 1

# INTRODUCTION TO CHEMICAL, BIOLOGICAL, AND RADIOLOGICAL OPERATIONS

## Section I. GENERAL

### 1. Purpose

*a.* This manual furnishes general guidance on the tactical employment of chemical and biological agents and provides an orientation in radiological operations. The basic information furnished in this manual complements the doctrine for chemical, biological, and radiological operations presented in FM 100–1 and FM 100–5.

*b.* Users of this manual are encouraged to submit recommended changes or comments to improve the manual. Comments should be keyed to the specific page, paragraph, and line of the text in which change is recommended. Reasons should be provided for each comment to insure understanding and complete evaluation. Comments should be forwarded direct to the Commandant, U.S. Army Chemical Corps School, Fort McClellan, Ala.

### 2. Scope

This manual describes the employment of toxic chemical agents, irritant chemical agents, smoke agents, flame, biological agents, and radioactive mate-

rials and their delivery means that are now available to the field commander or that will soon become available. Guidance on defense against enemy use of chemical, biological, and radiological agents is given in FM 21–40.

*a. Chemical Operations.* Detailed guidance for the employment of toxic chemical agents and chemical ammunition expenditure tables are given in TM 3–200 and TM 3–200A.

*b. Irritant Chemical Operations.* Detailed guidance for the employment of irritant chemical agents in riot control operations is given in FM 19–15 and TC 3–9; guidance for their use in training is given in FM 21–48.

*c. Smoke Operations.* Detailed guidance for the employment of chemical smoke generators is given in FM 3–50. Chemical smoke ammunition expenditure tables for artillery weapons are given in appendix II. Techniques of artillery delivery of smoke are described in FM 6–20 and FM 6–40.

*d. Flame Operations.* Detailed guidance for the employment of flame is given in FM 20–33.

*e. Biological Operations.* Detailed guidance for the employment of biological agents and munitions is given in TC 3–7.

*f. Radiological Operations.* Detailed guidance for radiological operations is given in FM 101–31.

*g. Nuclear Warfare.* The material presented in this manual pertinent to chemical and biological operations is applicable, without modification, during both nuclear warfare and nonnuclear warfare.

### 3. Chemical, Biological, and Radiological (CBR) Operations

The term "CBR" refers collectively to toxic chemical agents, biological agents, and radioactive materials; it is normally used to denote generalized activities such as CBR *training* or CBR *defense*. The terms "chemical operations," "biological operations," or "radiological operations" are used individually in this manual to denote specific types of activities and, in tactical operations, have the following meanings:

*a. Chemical Operations.* Chemical operations refer to the employment of toxic chemical agents to produce casualties among enemy personnel.

*b. Biological Operations.* Biological operations refer to the employment of biological agents to produce casualties among enemy personnel.

*c. Radiological Operations.* Radiological operations refer to the employment of radioactive materials to contaminate terrain for the purpose of producing enemy casualties or restricting enemy use of the area.

### 4. General Policies for Chemical, Biological, and Radiological Operations

Authority to initiate the tactical employment of toxic chemical agents, biological agents, or radioactive materials does not rest with the local commander. The local commander will receive guidance and authority to use these agents or materials through command channels. There are no restrictions on the initial employment of irritant chemical agents, smoke agents, and flame, subject to the policy guidance of the theater commander. Smoke and flame operations may be per-

formed at all levels within a field army, but they will normally be coordinated with the next higher headquarters and adjacent units.

*a. Chemical Operations.* After the initial use of toxic chemical agents is authorized, chemical operations will normally be planned and executed by divisions and higher units, subject to the policy restrictions of the theater commander. This guidance does not restrict the use of toxic chemical agents by units below division level, when such use is authorized.

*b. Biological Operations.* After the initial use of biological agents is authorized, biological operations will normally be planned and executed by army or independent corps and higher units, subject to the policy restrictions of the theater commander.

*c. Radiological Operations.* After the initial use of radioactive materials is authorized, radiological operations will normally be planned and executed in accordance with the policy restrictions of the theater commander.

## Section II. COMMAND RESPONSIBILITIES AND STAFF COORDINATION

### 5. The Commander

Although the commander may accept advice from his staff, he alone is responsible for any specific course of action involving the employment of toxic chemical agents, biological agents, or radioactive materials. The commander determines if, when, and where toxic chemical agents, biological agents, and radioactive materials will be employed to support tactical operations.

### 6. The Chemical Officer

The chemical officer is an adviser to the commander and his staff on matters relating to CBR operations—tactics and techniques, logistics, and training. During combat, the chemical officer is concerned primarily with CBR tactical operations and logistical support. During periods other than combat, the chemical officer is concerned primarily with plans and training that pertain to CBR operations. The chemical officer of a tactical unit has the following general responsibilities (FM 101–5):

*a.* Advises the commander and his staff on CBR matters, including the planning for and coordination of the use of chemical and biological weapons and munitions and radioactive materials by the various arms in tactical operations.

*b.* Advises the commander and his staff on CBR defense and prepares CBR defense plans.

*c.* Supervises the operation of CBR schools within the command.

*d.* Supervises the determination of requirements for, and the requisitioning, procurement, distribution, storage, and documentation of, Chemical Corps supplies, munitions, and equipment.

*e.* Plans and recommends requirements for, and employment of, Chemical Corps troops.

*f.* Exercises technical supervision over CBR training throughout the command.

*g.* Assists in the planning of chemical participation in barrier and denial operations.

*h.* Exercises technical supervision over the following CBR operations:

(1) Monitoring and decontamination of CBR contaminated areas.

(2) Planning for the use of toxic chemical agents, tactical smoke missions, large-area flame attacks, and biological agents in tactical operations.

(3) Planning and coordination of CBR surveys.

(4) Dissemination of technical intelligence pertaining to CBR capabilities of enemy units.

(5) Prediction of fallout from friendly and enemy nuclear weapons.

(6) Prediction of the casualty-producing effectiveness and degree of risk of toxic chemical agents, biological agents, and radioactive materials.

(7) Planning for the use and servicing of flame throwers and flame field expedients.

(8) Maintenance of chemical, biological, and radiological situation maps.

(9) Dissemination of chemical, biological, and radiological contamination charts, as required.

(10) Dissemination of radioactive fallout prediction charts.

(11) Maintenance and repair of Chemical Corps equipment and supplies, field impregnation of clothing, and field filling of Chemical Corps munitions.

(12) Technical inspection of Chemical Corps

equipment and supplies, to include organizational maintenance.

(13) Examination and processing of captured chemical, biological, and radiological materiel.

### 7. The Chemical, Biological, and Radiological Element (CBRE)

At field army and corps level, the staff activities associated with current tactical and tactical support operations are conducted in a tactical operations center (TOC), under the general staff supervision of the G3. The chemical element of the TOC is called the chemical, biological, and radiological element (CBRE). The CBRE can perform its mission whether it is a part of a TOC or of some other operations complex. The CBRE is part of the chemical staff sections of the tactical commands. At division level the chemical element is currently called the CBRC (chemical, biological, and radiological center). These chemical elements are generally concerned with the following and related activities:

*a.* Implementing CBR plans.

*b.* Analyzing targets for attack with toxic chemical agents and biological agents.

*c.* Assisting in planning nuclear attacks when fallout is a consideration.

*d.* Planning and coordinating the use of toxic chemical and antipersonnel biological agents, munitions, and weapons in tactical operations.

*e.* Predicting fallout from friendly and enemy nuclear strikes.

*f.* Predicting casualty-producing effectiveness of toxic chemical and antipersonnel biological attack.

*g.* Predicting the degree of risk resulting from toxic chemical and antipersonnel biological attack.

*h.* Controlling and coordinating CBR surveys.

*i.* Maintaining CBR situation maps.

*j.* Disseminating CBR information.

### 8. Chemical and Biological (CB) Support From Other Services

When targets are beyond or exceed ground force weapon capabilities, the commander may request chemical or biological support from appropriate Air Force or Navy commands. Requirements for tactical air chemical and biological (CB) support are made known to the Air Force, Navy, and Army Aviation through the tactical operations center (TOC). Requests for Air Force support are forwarded through the tactical air support element (TASE) at each level of command to independent corps or field army. The TASE at independent corps or field army passes the request to the tactical Air Force air support operations center (ASOC).

*a. Information To Be Furnished.* The request for a tactical air or naval chemical or biological mission forwarded through the TOC includes the following information:

(1) Target location.

(2) Target description.

(3) Results desired and type of agent or munition to be used.

(4) Tactical significance of the attack.

(5) Time of attack.

(6) Target distance and direction from friendly troops.

(7) Special control information—marking of front lines, special means of marking the target, and special bomb line.

(8) Other pertinent information—possible interference which the chemical or biological attack may have with operations of friendly adjacent units and on activities of friendly civilians.

*b. Prestrike Technical Coordination.* The chief of the CBRE advises the G3 air or naval representative on the following:

(1) The best chemical or biological munition that can be employed, and the best time and method of attack.

(2) The chemical or biological munitions requirements.

(3) The availability of ground chemical or biological munitions.

(4) The availability of and requirements for chemical service troops.

(5) Other pertinent technical information, such as the probable duration and stages of effectiveness of the agent-munition system recommended for use.

*c. Poststrike Technical Coordination.* After the air or naval chemical or biological attack is delivered, the chief of the CBRE that requested the attack informs

the chief of the CBRE of the next higher command of the technical aspects of the attack, to include the effectiveness of the agent-munition system used in the air or naval attack.

# CHAPTER 2

# CHARACTERISTICS OF CHEMICAL AGENTS AND MUNITIONS

## Section I. CHEMICAL AGENTS

### 9. General

Chemical agents are tactically classified into the following groups: toxic chemical agents, irritant chemical agents, smoke agents, and flame and incendiary agents. There is under development another group of chemical agents that incapacitate personnel. Chemical agents are described in detail in TM 3–215. The U.S. Army code designation for any chemical agent is a combination of one to three letters; it is frequently used instead of the name of the chemical agent.

### 10. Toxic Chemical Agents

Toxic chemical agents produce lethal or injurious effects on personnel when in contact with the skin or when inhaled. The standard toxic chemical agents are described in detail in TM 3–200 and TM 3–200A. The currently standard toxic chemical agents for use in combat are—

*a. Nerve Agent GB.* GB is a quick-acting chemical agent that in liquid or vapor form produces casualties ranging from incapacitation to death by paralyzing

respiratory muscles of exposed personnel. Inhalation of GB vapors can cause casualties within minutes. Contact of liquid GB with the skin can also cause casualties quickly.

*b. Nerve Agent VX* (see TM 3–200A for classified information). In liquid form, VX is a delayed-acting chemical agent that produces physiological effects similar to those produced by GB. In aerosol form, VX can cause casualties quickly.

*c. Blister Agent HD.* HD is a delayed-acting chemical agent that in liquid or vapor form produces casualties among exposed personnel by its blistering action on the eyes, skin, or parts of the respiratory system. Initial symptoms of HD exposure to the skin and lungs usually appear in 4 to 6 hours; eyes may be affected within minutes.

### 11. Irritant Chemical Agents

Irritant chemical agents produce temporary irritating or disabling physiological effects when in contact with the eyes and skin or when inhaled by personnel. The currently standard irritant chemical agents for use in training and riot control or against hostile personnel are—

*a. CN (Chloroacetophenone).* CN is a quick-acting solid that when disseminated as an aerosol causes an intense flow of tears and irritates the eyes, skin, and upper respiratory passages. CNC is a solution of CN dissolved in chloroform. When disseminated as an aerosol, CNC produces effects similar to those produced by CN.

*b. DM (Adamsite).* DM is a solid that when dis-

seminated as an aerosol causes violent sneezing, nausea, and vomiting. DM may be mixed with a quick-acting irritant such as CN in munitions to obtain combined effects.

*c. CS.* CS is a quick-acting irritant of the eyes, nose, and throat; in high concentrations, it may also cause vomiting. It is a solid that is used primarily for riot control and can be disseminated from burning-type munitions, from bursting-type grenades, and by mechanical aerosol dispersers.

*d. Chlorine (Cl).* Chlorine is a toxic training agent used primarily in gas chambers for training troops. It is a true gas and a quick-acting irritant of the respiratory tract.

### 12. Smoke Agents

Smoke agents produce fine solid or liquid particles suspended in air, causing an obscuring effect. Smoke is classified as—

*a. Screening Smoke.* The following smoke agents are used in training and in combat to produce screening smoke:

(1) *SGF (fog oil).* SGF is a special petroleum oil that produces a very dense white smoke when vaporized and condensed. It normally causes no adverse physiological reaction when personnel are exposed to it in field concentrations and has no adverse effect on materiel.

(2) *WP (white phosphorus).* WP is a solid that burns when exposed to air, forming a very dense white smoke. PWP (plasticized white phosphorus) is a mixture of WP and rubber

gel. Burning particles of the agent scattered by bursting-type ammunition can cause personnel burns that are painful and slow to heal.

(3) *HC (hexachloroethane mixture).* HC is a solid that when burning produces a grayish white smoke slightly less dense than that produced by WP. Long exposure to field concentrations of this smoke may irritate or incapacitate unprotected personnel.

(4) *FS (sulfur trioxide-chlorosulfonic acid solution).* FS is a liquid that when exposed to air forms white smoke less dense than that formed by WP. This acid smoke irritates the skin of exposed personnel and is highly corrosive to some types of materials and paints.

*b. Signaling Smoke.* Signaling smoke is produced by a fuel that contains an organic dye. When the fuel is burned, the dye is vaporized and then is condensed to form the colored smoke.

### 13. Flame Fuels and Incendiary Agents

Flame is employed primarily against personnel, and incendiary agents are used primarily to destroy materiel.

*a. Flame.* Flame fuels consist of special blends of petroleum products, usually in thickened form. Those in thickened form are viscous liquids that can easily be ignited and can be projected toward a target. Flame is used in combat to produce casualties by burning personnel and, in inclosed places, by causing additional physiological effects through depletion of the oxygen supply. Flame fuels are described in detail in TM 3–366.

*b. Incendiaries.* Incendiary agents consist of a combination of flammable substances that burn with an intense heat.

### 14. Incapacitating Chemical Agents

Incapacitating chemical agents are capable of producing physiological or mental effects that prevent exposed personnel from performing their primary military duties for a militarily significant period of time; there is complete recovery from these effects.

## Section II. METHODS OF DISSEMINATION

### 15. General

The behavior and effectiveness of chemical agents vary widely with the method of dissemination. Chemical agents may be disseminated by bursting-type munitions, generating-type equipment and munitions, pressure-type weapons and munitions, and spray-type equipment.

### 16. Bursting-Type Munitions

Bursting-type munitions include artillery and mortar shells, rockets, bombs, grenades, and land mines. When a chemical-agent-filled munition impacts on a target, an explosive burster ruptures the munition and disperses the agent filling. Some of the chemical filling may be driven into the crater formed by the explosive burst, some of it may be decomposed by the explosion, and the major part of it is formed into a cloud of vapor and aerosol (fine liquid or solid particles suspended in air).

*a. Cloud Formation.* The dimensions of the vapor

and aerosol cloud formed are influenced by the type and amount of chemical agent filling, the type of fuze, the burster charge, the nature of the burst (surface or air), the thickness of the walls of the munition, and the weather and terrain. If there are sufficient bursts under suitable conditions in the target area, clouds from adjacent bursts merge to form a continuous cloud over the greater part of the target area.

*b. Cloud Behavior.* The vapor and aerosol portions of the cloud travel downwind until they lose their effectiveness by dilution with the air. Larger liquid or solid particles of the agent settle to the ground or impact on any surface which they meet. The larger and heavier particles settle out more rapidly than do the smaller and lighter particles.

### 17. Generating-Type Equipment and Munitions

The generating-type equipment and munitions employ heat to vaporize and disseminate chemical agents.

*a. Mechanical Generator.* The mechanical smoke generator is an example of this type of equipment; it operates on the principle of vaporizing the smoke agent in hot combustion gases. The vaporized agent is then forced through outlet nozzles into the atmosphere where it cools rapidly and condenses into an aerosol of very small liquid droplets. Favorable winds are used to disseminate the agent into the target area.

*b. Thermal Generator.* The SGF floating smoke pot is an example of this type of equipment; it operates on the principle of using heat to vaporize the smoke agent.

*c. Burning-Type Generator.* The CN–DM grenade is an example of this type of munition; it operates on the principle of burning a mixture, which includes an irritant chemical agent, to produce heat that vaporizes the chemical agent.

### 18. Pressure-Type Weapons and Munitions

The pressure-type weapons and munitions employ industrial compressed gases to project chemical agents toward the target.

*a. Mechanical Pressure Weapons.* The portable flame thrower, an example of this type of weapon, employs a cylinder of compressed air to project the chemical agent toward the target. When flame fuel is used, it is ignited and projected as a rod of flame toward the target.

*b. Field Expedient Munitions.* The flame mine, an example of this type of munition, employs a bursting charge to generate the gases necessary to project the flame out of the mine.

### 19. Spray-Type Equipment

Spray-type equipment can be used to disseminate large quantities of liquid or solid particle chemical agents. U.S. Army aircraft have a capability to disseminate chemical agents as spray. When the liquid chemical agent is released from the spray-type equipment, the agent is immediately shattered into fine droplets. The cloud formed by spray-type equipment is affected by weather and terrain in much the same way as that formed by bursting-type munitions.

## Section III. EFFECTS OF WEATHER

### 20. General

Weather influences chemical agents in vapor or aerosol form more than it influences those agents in liquid or solid form. The behavior and effectiveness of chemical agent vapors and aerosols are influenced by air stability, wind speed, temperature, humidity, and precipitation. Liquid chemical agents used to contaminate terrain are influenced principally by temperature and precipitation. The Air Force is assigned the responsibility of providing ground commanders with both long-range weather forecasts and meteorological data for specific operations. The unit intelligence officer obtains these weather forecasts from the Air Weather Service. Although the artillery ballistic meteorological system does not forecast weather, it may be used within its capabilities to provide some usable data. A detailed description of weather and its effects may be found in TM 3–240.

### 21. Air Stability

Vertical changes in temperature called temperature gradients affect air stability. The temperature gradient microweather forecast furnished by the Air Weather Service is the algebraic difference between the air temperature 0.5 meter above the ground and the air temperature 2 or 4 meters above the ground. For the numerical values given below, the air stability conditions are—

| *Temperature gradient (in degrees Fahrenheit)* | *Air stability condition* |
|---|---|
| Greater than 2 | Inversion |
| 2 to —2 | Neutral |
| Less than —2 | Lapse |

Conditions of air stability that affect chemical agent clouds (fig. 1) are as follows:

*a. Inversion (Stable) Condition.* An inversion condition exists when the lower layer of air is cooler than the upper layer of air. This condition usually exists on clear or partially clear nights and early mornings until about 1 hour after sunrise. It is characterized by a minimum number of convection currents and by maximum air stability. Under an inversion condition with wind speeds below 4 knots (about 5 miles per hour), chemical agent clouds can travel considerable distances without becoming too diluted to be effective.

*b. Lapse (Unstable) Condition.* A lapse condition exists when the lower layer of air is warmer than the upper layer of air. This condition usually exists on clear or partially clear days. It is characterized by turbulence from thermal air currents, which tends to quickly disperse chemical agent clouds.

*c. Neutral Condition.* A condition between lapse and inversion is called a neutral condition. This condition exists when upper and lower layers of air are approximately the same temperature—usually on heavily overcast days or nights, 1 or 2 hours before sunset, and 1 or 2 hours after sunrise.

## 22. Wind Speed

Generally, high winds rapidly disperse toxic chemical agent clouds, thus decreasing their effectiveness. Large-area nonpersistent chemical attacks are most effective when the wind speed is not over 18 knots (about 20 miles per hour). Small-area nonpersistent chemical attacks are most effective in wind speeds of

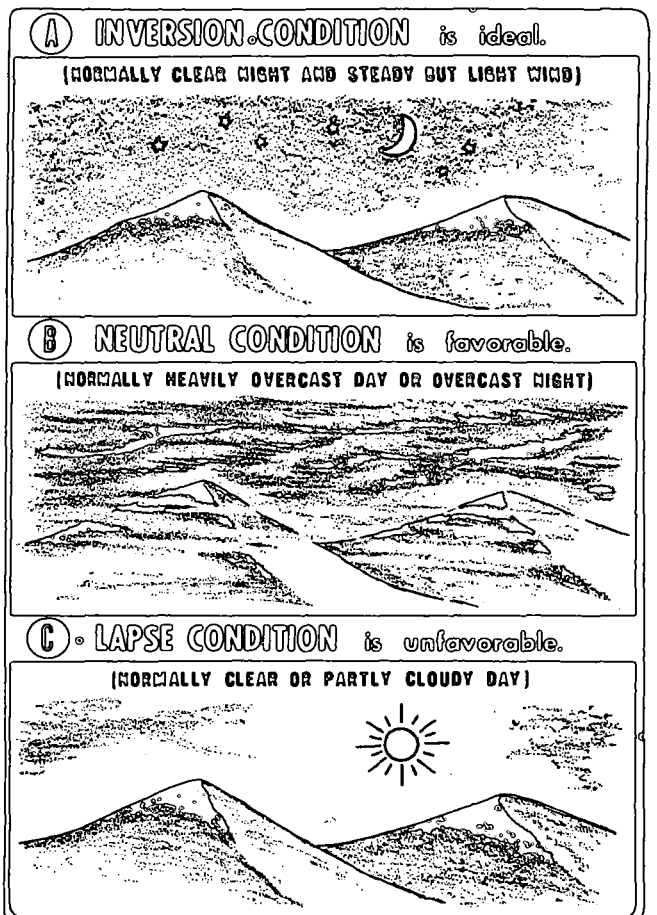


*Figure 1. Air stability affects behavior of chemical agent clouds.*

less than 7 knots (about 8 miles per hour). The effects of high wind speeds can be partially offset if the concentration of chemical agents can be established quickly in the target area; however, increased munition expenditures are required. The rate of evaporation of liquid chemical agents on the ground is increased in high wind speeds. Increased evaporation increases the danger from toxic vapors; however, high winds quickly disperse the vapor.

### 23. Temperature

The effectiveness of most toxic chemical agents varies with temperature. High temperatures increase the rate of evaporation of liquid chemical agents on the ground and decrease the duration of effectiveness; the reverse occurs at low temperatures. The degree to which temperature variations limit the tactical use of most toxic chemical agents is dependent on the physical properties of the chemical agent, the manner in which it is dispersed, and the seasonal or climatic clothing of target personnel.

### 24. Humidity and Precipitation

High humidity increases the physiological effectiveness of some toxic chemical agents, such as the blister agent HD. Chemical agents that hydrolyze rapidly may be adversely affected by high humidity. Humidity does not seriously decrease the effectiveness of most chemical agents in field concentrations. Heavy or lasting rains wash away most liquid chemical agents. Snow may cover liquid chemical agents so that a decreased vapor hazard exists until the snow melts.

## Section IV. EFFECTS OF TERRAIN

### 25. General

The behavior and effectiveness of most chemical agents are influenced by the contour and condition of the ground surface and by the presence or absence of trees and vegetation (fig. 2).

### 26. Contour of Terrain

Chemical agent clouds tend to flow over rolling terrain and down valleys, to remain in hollows and on low ground and depressions, and to go around obstacles. Local winds, coming down valleys at night and up valleys in the daytime, may deflect the clouds or reverse the forecast flow; likewise, they may produce favorable conditions for cloud travel. Uneven terrain, including ground covered with tall grass or brush, retards the flow of the clouds; flat country or open water promotes an even, steady flow of the clouds. Under some conditions, large streams and rivers may divert the path of the aerosol or vapor clouds. Obstacles, such as buildings and clumps of trees, break up the vapor or aerosol cloud so that it may dissipate rapidly. Over land areas adjacent to large bodies of water, daytime breezes are usually from the water and nighttime breezes are usually from the land.

### 27. Surface of Terrain

Ground conditions influence agent cloud size, shell penetration, cratering, and the degree of liquid contamination of chemical artillery shell that detonate on impact with the ground. The presence of rain or snow alters the surface condition. The following conditions may be considered:

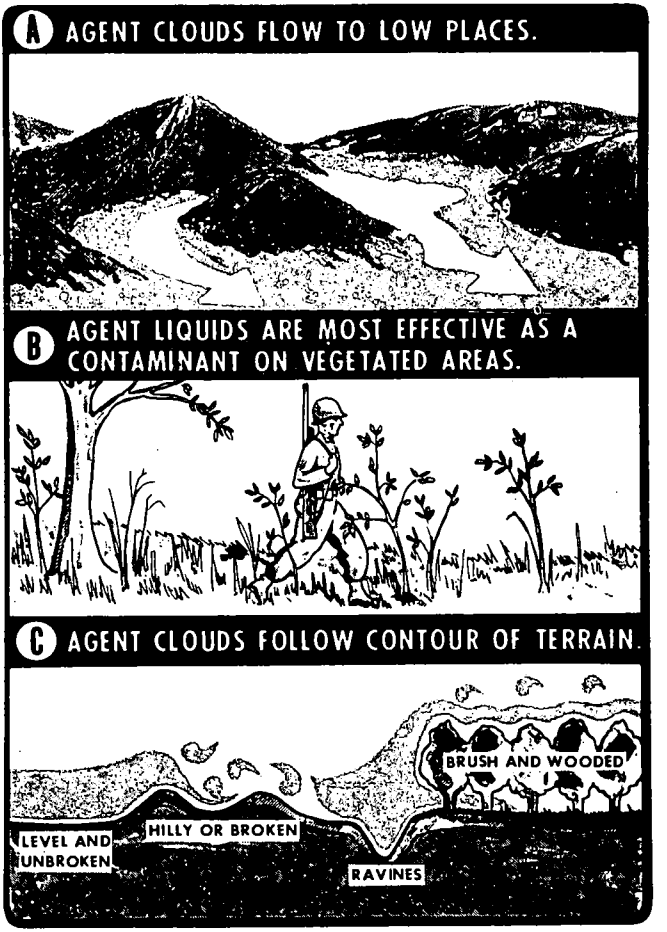


*Figure 2. Terrain affects behavior of chemical agents.*

*a. Soft Surface.* Point-detonating chemical ammunition tends to bury into soft ground before bursting. Much of the chemical agent cloud is, therefore, funneled up to a height sufficient to cause some dispersion and loss of effectiveness. Also, part of the chemical filling remains in the crater. Under unfavorable conditions, loss of chemical agent from funneling and cratering may be as high as 20 percent of the total filling.

*b. Hard Surface.* No appreciable loss of the chemical agent occurs when bursting-type chemical ammunition falls on hard ground. Liquid chemical agents contaminate the surface and constitute a contact hazard. Moreover, the liquid chemical agent evaporates more readily and achieves a better vapor return from hard surfaces than from soft surfaces.

*c. Porous Surface.* If the surface on which the liquid toxic chemical agent falls is porous (such as earth, sand, brick, or wood), the liquid chemical agent quickly soaks in and some loss of effectiveness occurs. The rate of evaporation from porous surfaces is, in general, much lower than that from nonabsorbent material. Sand is much more absorbent than grassland.

### 28. Trees and Vegetation

More effective toxic chemical agent cloud concentrations can generally be built up in heavily wooded or jungle areas than on open terrain. The term "heavily wooded" is used to denote jungle or forest with canopies of sufficient density to shade more than 90 percent of the ground beneath them. In chemical operations, an area containing scattered trees or clumps of bushes is considered open terrain. During the day temperatures are generally lower in wooded areas than in open

terrain. In wooded areas where trees are not in leaf or where the foliage has been destroyed by previous high explosives or chemical attacks, sunlight strikes the ground and temperature gradients parallel those existing in the open.

*a. Wooded Areas.* Initial chemical agent clouds formed from bursting-type munitions within woods in leaf and under a jungle canopy are comparatively smaller and contain higher concentrations than those clouds formed on open terrain. Within a forest there are usually lower wind speeds (ranging from 0 to 3 knots) and more foliage, brush, and tree trunks to retard the flow of air; consequently, chemical agent clouds formed within woods travel more slowly than they do over open terrain. Chemical spray attacks are not as effective when made over a thick jungle or woods in leaf as when made in the open.

*b. Vegetated Areas.* Contamination of vegetated areas by liquid toxic chemical agents such as HD is generally more effective against troops on foot than is contamination of open areas because of the increased probability of troops brushing against the contaminated vegetation.

# CHAPTER 3

# EMPLOYMENT OF TOXIC CHEMICAL AGENTS

## Section I. CAPABILITIES AND CHARACTERISTICS

### 29. General

Toxic chemical agents have capabilities, characteristics, and effects that must be recognized and carefully evaluated before they can be employed to the greatest advantage in tactical operations. Toxic chemical agents are employed, basically, to produce casualties among enemy personnel. They are employed as a vapor or an aerosol to produce casualties by inhalation or as a liquid to produce casualties by contact with the skin. Some toxic chemical agents produce casualties by skin absorption of liquid, vapor, or aerosol. The more important capabilities and characteristics of toxic chemical agents are described in paragraphs 30 through 36. Technical information on the employment of toxic chemical agents in tactical operations is given in TM 3–200 and TM 3–200A.

### 30. Reduction in Enemy Effectiveness

Toxic chemical agents, effectively employed, not only can cause severe enemy personnel losses but also can drastically reduce enemy firepower, operating efficiency, combat effectiveness, and maneuver capability. This reduction in enemy effectiveness results from the

following enemy reactions to a chemical attack:

*a.* Protective action required during the chemical attack on the target.

*b.* Decontamination activities required to permit continued use of the target area.

*c.* Interference with normal activities resulting from the wearing of protective equipment after the chemical attack.

### 31. Selectivity

Toxic chemical agents and munitions for their dissemination can be selected to produce a desired effect in a given situation. Toxic chemical agents differ among themselves in physical behavior and in effect on the target. The effects on personnel range from harassment to death. These effects can be achieved by direct attack on personnel or by the contamination of terrain and materiel. For example, VX is effective in restricting the use of terrain and materiel and in causing casualties; GB can produce lethal or incapacitated casualties without damaging installations and facilities. These installations, facilities, and materiel can be recovered by decontamination, if necessary.

### 32. Persistency (Duration of Effectiveness)

Under favorable conditions some toxic chemical agents can remain effective in the target area for an appreciable length of time, thereby creating a continuing hazard to those personnel moving into the area as well as to those already there. By the selection of a suitable agent-munition combination, the time an agent remains effective in the target area can be varied from a few minutes or hours to a number of days.

### 33. Penetration of Fortifications

Most toxic chemical agents can be disseminated as a vapor or an aerosol. Toxic vapors or aerosols form a cloud of agent that can penetrate the openings of fortifications and installations (fig. 3) and envelop most battlefield obstacles. This characteristic of toxic clouds reduces the effectiveness of cover.

### 34. Area Coverage

Winds can move vapor or aerosol clouds of toxic chemical agents considerable distances from the target area. The downwind area affected by the toxic cloud may be up to 25 times as large as the target area itself. This downwind travel characteristic of toxic clouds greatly increases the overall agent effectiveness.

### 35. Effects Against Concealed Troops

Toxic chemical agents can be used against area targets in which enemy troops are known to be dispersed but cannot be located exactly. The toxic chemical cloud can envelop concealed enemy troops and produce casualties. Thus, toxic chemical clouds have the capability of reducing the effectiveness of enemy camouflage and concealment measures.

### 36. Fragmentation Effects

In addition to the casualty effects from the toxic chemical agent, bursting-type chemical munitions produce some casualties among enemy troops from the fragmentation effects of the shell burst. The fragmentation effectiveness of nerve agent chemical ammunition is approximately one-half of that of the corresponding HE rounds bursting under similar conditions.

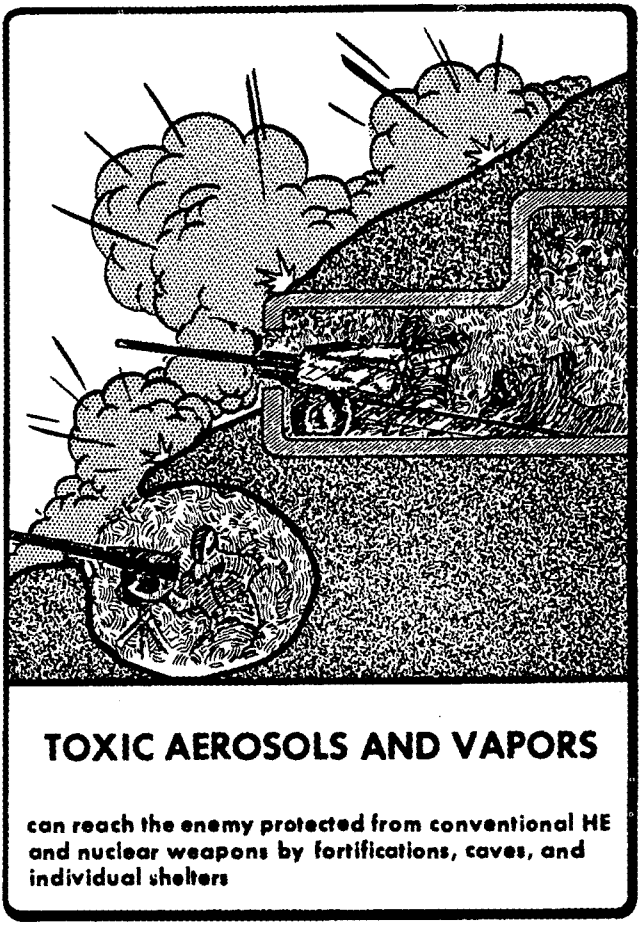


*Figure 8. Toxic aerosols and vapors penetrate fortifications.*

## Section II. NONPERSISTENT EFFECT

### 37. General

In a chemical attack for nonpersistent effect, the toxic chemical agent is disseminated as a vapor or an aerosol to kill or disable personnel. The agent is delivered to the target by bursting-type munitions that are designed to produce the optimum vapor or aerosol. The vapor or aerosol formed is effective against unprotected personnel both at the point of release of the agent and in the downwind path of the toxic cloud. The toxic cloud may remain effective in the area of release for several minutes and, depending on weather and terrain, may continue to be a casualty threat as it moves downwind.

### 38. Objectives

The principal objectives of a chemical attack for nonpersistent effect are to—

*a. Produce Casualties Through Surprise.* When enemy personnel are equipped with protective masks and are well trained in their use, it is essential that the agent be delivered directly on the target area in the shortest possible time. Since well-trained troops take protective action quickly, a surprise concentration of agent is therefore required to cause inhalation of casualty dosages before enemy troops can mask.

*b. Harass.* The high toxicity of some chemical agents such as GB imposes a casualty threat among unmasked personnel even in low concentrations. Harassing effects can be achieved when GB shell are fired intermittently into an area to force personnel to remain masked over long periods of time. GB rounds inter-

spersed in HE fire also cause enemy masking and alerts. Some casualties can be expected as a result of wearing the protective mask for extended periods. Even a moderate beard interferes with proper fitting of the US-type protective mask and causes some mask leakage. However, when harassing fires with toxic chemical agents are used over a period of time, personnel are alerted and this alertness decreases their vulnerability to surprise chemical attack.

*c. Produce Casualties Through Poor Gas Discipline.* In any chemical attack, some personnel are exposed to the agent through failure to put on the mask rapidly, through damaged or improperly worn masks, and through failure of the warning system to alert all personnel in the target area and in the downwind path of the toxic cloud. Sleeping personnel and isolated groups and individuals, such as those in working and reconnaissance parties, are particularly vulnerable.

*d. Produce Casualties Through Cumulative Effect.* Any exposure to GB lowers the body cholinesterase level. Repeated exposures to even low dosages over a period of days or weeks gradually lower the cholinesterase level until the individual becomes a casualty. Each exposure to GB thus increases the individual's vulnerability to successive attacks. Complete physiological recovery from exposure to nerve agents such as GB generally requires several months.

*e. Produce Casualties Among Unprotected Personnel.* When intelligence indicates a lack of protective equipment among enemy personnel, casualties can easily be achieved by the exposure of target personnel to low concentrations of toxic chemical agents over a

long period of time. In this situation it is not necessary to deliver high concentrations of toxic chemical agents in a short period of time.

### 39. Techniques of Nonpersistent Chemical Attack

Chemical munition expenditures and techniques of delivery for a nonpersistent chemical attack are based on the achieving of either surprise dosage effects or total dosage effects.

*a. Surprise Dosage Attack.* Surprise dosage refers to the vapor or aerosol effects that are maintained by the massing of chemical munitions on the target area within a 30-second period. Surprise dosage attack requires on-target concentrations of chemical munitions, with downwind effect considered as a bonus. Artillery, mortars, or rockets fire chemical ammunition either as time-on-target concentrations or in battery or battalion volleys. The relatively slow rate of fire and small-area coverage of cannon artillery may require the massing of fires of many artillery units of different calibers to cover appreciable target areas. Chemical rockets can cover larger target areas than can cannon artillery. Careful fire planning and timing of artillery fires are required for maximum surprise effect. Surprise dosage chemical fires initiate the artillery preparation. If chemical ammunition is fired at times other than the start of artillery preparation fire, enemy target personnel may be alerted to the imminence of the attack by the initiation of HE fires and may put on their protective masks. Firing chemical ammunition at the start of the artillery preparation provides maximum time for dissipation of the toxic chemical agent from the impact area, thus minimizing

hazards to friendly troops attacking through the area.

*b. Total Dosage Attack.* Total dosage refers to the total vapor or aerosol effects that are attained from a given expenditure of chemical munitions over a variable period of time, depending on terrain and meteorological conditions. Total dosage attacks are effective when used as a part of a planned attrition program, over a period of several days or weeks, to cause casualties through poor gas discipline and through the cumulative effect of repeated exposures. Total dosages are also effective when used against unprotected personnel. Rapid delivery of chemical munitions on the target is desirable but not necessary. Chemical munition concentrations can be fired either on the target or off the target with reliance on downwind toxic cloud travel to obtain target area coverage. Maximum casualty effect is achieved by on-target concentrations of chemical munitions; as the toxic cloud travels downwind, it is effective against other targets in its path. Total dosage attacks are most effective at night because more favorable meteorological conditions exist at that time and personnel may be less alert than during the day. Total dosage fires may be integrated with HE fires.

## Section III. PERSISTENT EFFECT

### 40. General

In a chemical attack for persistent effect, the toxic chemical agent is disseminated as a liquid to produce casualties or to restrict the use of terrain, equipment, and materiel through the threat of casualties. The agent can be disseminated on the target by bursting-

type munitions and aircraft spray. HD and VX munitions are designed to give maximum return of the liquid agent for terrain contamination. HD vapor is also produced by the bursting of HD munitions and by evaporation of the liquid agent from contaminated terrain. Casualties result from exposure of personnel to either HD vapor or HD liquid. HD and usually VX produce delayed casualty effects, which must be considered in planning.

### 41. Objective

The principal objectives of a chemical attack for persistent effect are to—

*a. Circumvent the Protection of the Mask and Produce Casualties.* HD and VX can produce casualties among masked personnel. HD liquid or vapor produces casualties primarily through skin contact. Liquid HD contamination is most effective in vegetated areas, since personnel moving through the area pick up HD by brushing against the vegetation. HD vapor, whether from bursting ammunition or from evaporation of the liquid agent on the ground, is effective against the eyes, skin surfaces, and lungs of personnel. Casualties resulting from exposure of skin surfaces to HD vapor are best obtained under hot, humid conditions when skin surfaces are moist. Protective clothing provides personnel almost complete protection against field concentrations of HD vapor. However, liquid HD and VX may produce some casualties among masked personnel wearing protective clothing by their ability to *slowly* penetrate permeable protective clothing.

*b. Hamper or Restrict the Use of Terrain and Materiel.* The presence of contaminated terrain in his zone of operations poses three alternatives to the enemy: to avoid the contaminated terrain; to cross it and accept casualties; or to expend time, manpower, and materials to decontaminate it. Traversal of contaminated terrain by troops on foot normally slows down their rate of advance, thus increasing their vulnerability to conventional fire. The decontamination of personnel and equipment is time-consuming and imposes an additional logistical burden on the enemy. The use of protective clothing reduces the casualty effects of liquid contamination.

*c. Force Enemy Troops to Vacate an Area.* The contamination of an occupied area poses three alternatives to the enemy: to remain in the area and accept casualties; to vacate the area; or to expend time, manpower, and materials to decontaminate it. Area decontamination can, at best, reduce the hazard but cannot completely eliminate it.

*d. Increase the Effectiveness of Minefields and Demolitions.* Liquid chemical contamination of minefields and demolitions increases the effectiveness of these obstacles by complicating the clearing and breaching operations in minefields and by delaying the repairing of damaged facilities and materiel. Personnel engaged in these activities must wear protective clothing to reduce the risk of becoming casualties.

## 42. Techniques of Persistent Chemical Attack

Chemical munition expenditures for a persistent chemical attack provide for both liquid contamination

effect and vapor effect. HD and VX can be delivered to targets by ground weapons such as cannon artillery, mortars, and rockets. Cannon artillery fire chemical ammunition into the target area so that rounds are randomly distributed. The time of firing is not a critical factor and is determined by the tactical situation; fire missions of up to 15 minutes are acceptable.

*a. Liquid Contamination Attack.* In terrain restriction operations, HD and VX may be used on occupied or unoccupied terrain. To maintain the effectiveness of liquid contamination, periodic replenishment fires are required to refresh the contamination.

*b. Vapor Attack.* HD is used for vapor effect on occupied targets only when delayed casualties are acceptable and friendly forces do not intend to enter the target area immediately. Artillery units fire HD ammunition into the target area rapidly until the desired concentration is achieved.

# CHAPTER 4

# EMPLOYMENT OF IRRITANT CHEMICAL AGENTS, SMOKE, AND FLAME AND INCENDIARIES

## Section I. EMPLOYMENT OF IRRITANT CHEMICAL AGENTS

### 43. General

Irritant chemical agents are used to temporarily incapacitate hostile or riotous personnel for short periods of time. They can also be used against rebellious prisoners of war and to control rioting civilians. In low concentrations they are used to train friendly troops in defense against chemical attack. The selection of the proper irritant chemical agent to use in a particular situation is dependent upon the physiological effects desired and the dissemination means available for the agent.

### 44. Characteristics of Irritant Chemical Agents

Irritant chemical agents consist of solids that can be ground into minute particles (micropulverized) or dissolved in a solvent. In general, micropulverized irritant chemical agents are more persistent than the liquid agent. When irritant chemical agents are used in field concentrations, they do not injure personnel.

When irritant chemical agents are used in inclosed places, resulting high concentrations can incapacitate personnel for several hours and can result in serious physiological reactions. The following irritant chemical agents are used against hostile or rioting personnel:

*a. CN.* CN irritates the upper respiratory passages, in addition to causing an intense flow of tears within seconds of exposure of unmasked personnel. In high concentrations CN is irritating to the skin and can cause a burning and an itching sensation, especially on moist parts of the body. Some individuals experience nausea following exposure to CN. During the time that personnel are exposed to CN and for a few minutes after they are exposed to fresh air, they are incapable of effective action.

*b. DM.* Since DM requires 15 to 30 minutes to produce maximum effects, it is frequently combined with CN in munitions to produce a quicker effect. The physiological reaction to DM is sufficiently violent to incapacitate personnel for several hours after exposure. DM is particularly useful against violent rioters. DM poisons open food and water supplies; therefore it should be used with caution.

*c. CS.* CS is used primarily in riot control operations. It is effective even in extremely low concentrations. Its effects on the eyes and repiratory system are produced within seconds and continue for 5 to 10 minutes after personnel are exposed to fresh air; during this time personnel are incapable of effective

action. Particle size, concentration, and local weather conditions, rather than duration of exposure, determine the effectiveness of CS. Any amount of CS that the individual breathes before masking or that is trapped in the mask while it is being put on continues to be effective, giving the impression that the mask is leaking. This impression, coupled with such effects as chest tightness, nausea, and a burning sensation of the eyes, frequently causes personnel to remove their masks, thereby exposing them to more effective concentrations of CS or of any other chemical agent being used with CS.

### 45. Effects of Weather and Terrain

The weather and terrain factors that affect the employment of irritant chemical agents are wind direction, wind speed, atmospheric stability, contour of terrain, and trees and vegetation (pars. 21, 22, 26, and 28). Foliage and high grass increase the persistency of micropulverized agents.

### 46. Methods of Dissemination

The selection of the most effective method of disseminating irritant chemical agents is dependent on the size of the target area and the character of target personnel. Army aircraft have the capability to disseminate irritant chemical agents. Munitions and equipment that can be used to disseminate irritant chemical agents include—

*a. Skid-Mounted Disperser.* This weapon can disperse about 40 pounds of micropulverized irritant chemical agent in 3 minutes. The irritant agent is projected approximately 15 meters prior to billowing

out into a cloud. The disperser, when mounted in a truck or trailer traveling about 8 knots, can cover a 400-meter frontage. In an 11- to 13-knot wind, the effective downward coverage is about 500 meters.

*b. Helicopter- or Vehicle-Mounted Disperser.* This weapon can disperse about 100 pounds of micro-pulverized irritant chemical agent in 2 minutes. A helicopter flying about 44 knots in a 13-knot wind can cover a 1,200- to 1,500-meter frontage with a 500-meter downwind coverage.

*c. Portable Disperser.* This weapon consists of a special gun connected to a standard flame thrower tank group and hose assembly. It can disperse about 20 pounds of pulverized irritant chemical agent in 30 seconds. In a wind speed of 4 to 6 knots, this weapon can cover 2,300 to 3,800 square meters. The effective downwind coverage is greater than 200 meters.

*d. Grenades.* There are two types of irritant chemical agent grenades. The burning-type grenade can cover about 250 square meters in an 8- to 13-knot wind; three bursting-type grenades can cover about 1,200 square meters in an 11- to 16-knot wind.

### 47. Employment of Irritant Chemical Agents in Friendly Areas

When employed against rioters in friendly areas (see FM 19–15), irritant chemical agents are used in sufficient quantities to produce an immediate and a decisive effect. Avenues of escape from the advancing irritant agent cloud must be provided for members of a rioting civilian mob. Except in extreme emergencies, irritant chemical agents are not used when

patients in hospitals or children in schools may be affected. Under these conditions the employment of irritant chemical agents is coordinated with the civil affairs staff officer (G5).

*a. Grenades.* Burning-type grenades are thrown or projected by a grenade launcher over or in front of a mob. Bursting-type grenades are tossed into the air so that the burst occurs several feet over the heads of the mob.

*b. Mechanical Dispersers.* When a larger amount of agent is required than can be obtained by the use of standard grenades, mechanical dispersers are used. They are so employed that the agent cloud is sustained until the mob is forced to leave the area.

### 48. Employment of Irritant Chemical Agents in Enemy Areas

There are special situations when irritant chemical agents can be employed effectively against enemy troops.

*a. Intelligence Purposes.* Irritant chemical agents can be used to subdue enemy troops in tanks, outposts, caves, bunkers, and other strongpoints to assist in capturing personnel for intelligence questioning.

*b. Proximity to Friendly Civilians.* Irritant chemical agents can be used to subdue small numbers of enemy troops in close proximity to friendly civilians in buildings, towns, and bypassed areas without seriously harming the civilians.

*c. Interference With Masking.* Irritant chemical agents can be used to interfere with the masking of enemy troops to make the subsequent use of toxic chemical agents more effective.

## Section II. EMPLOYMENT OF SMOKE

### 49. General

Smoke is employed in combat to reduce the effectiveness of enemy visual observation. This reduction is accomplished by the use of projected smoke on enemy observation points, emplaced smoke on friendly units and installations, and projected or emplaced smoke between enemy observation points and friendly units or installations. Some types of smoke are used for signaling purposes.

### 50. Characteristics of Smoke

The characteristics of smoke produced by mechanical smoke generators and smoke pots (see FM 3–50) are different from the characteristics of smoke produced by bursting-type ammunition. Smoke from WP ammunition may pillar for 2 or 3 seconds after the burst and under some conditions may form a "mushroom" effect. This pillar collapses when it cools and may merge with other bursts to produce a cloud formation (fig. 4). PWP burns slower than does WP, producing smoke with less pillaring.

*a. Screening Smoke.* Screening smoke is generally white or gray, since these colors produce the maximum obscuring effect. The tactical and logistical situations, including deception plans, will greatly influence the choice of screening smoke effect to be used (fig. 5). Smoke can be employed to produce a—

(1) *Smoke blanket,* a dense smoke concentration established over an area to prevent enemy visual observation and enemy visual precision bombing. Visibility in a smoke blanket

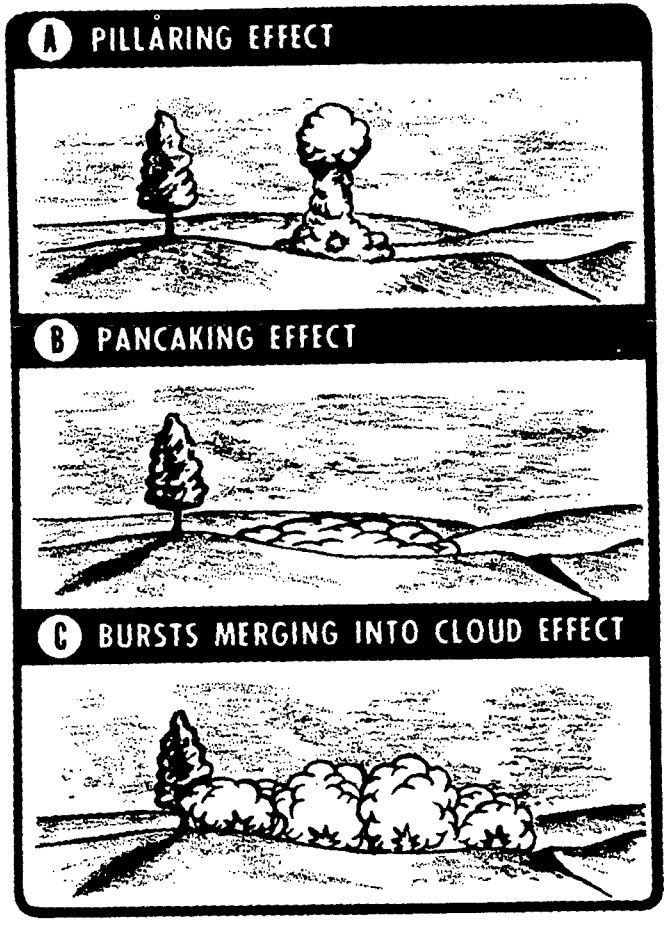


*Figure 4. Cloud effects of bursting-type smoke ammunition.*

is restricted, allowing limited friendly operations to take place.

(2) *Smoke haze,* a light smoke concentration established over an area to reduce enemy visual observation during daylight or moonlight. Enemy observation is reduced, whereas friendly forces can operate easily within the haze. Visibility in a smoke haze is normally from 135 to 180 meters.

(3) *Smoke curtain,* a vertical smoke screen established between enemy observation and friendly units to obscure enemy ground visual observation.

(4) *Blinding smoke,* a smoke concentration placed directly on enemy positions to obscure enemy visual observation into friendly territory. Blinding smoke is delivered by ground or air means.

*b. Signaling Smoke.* Signaling smoke is available in several colors and can be used to—

(1) Mark enemy or friendly positions by smoke emission on the ground.

(2) Transmit specific messages by prearranged color codes.

## 51. Effects of Weather

Wind speed and direction have a major influence on the effectiveness of a smoke screen. Other weather factors have little effect on smoke produced by smoke generators and a moderate effect on smoke produced by other means.

*a. Wind Speed.* The optimum wind speed for the

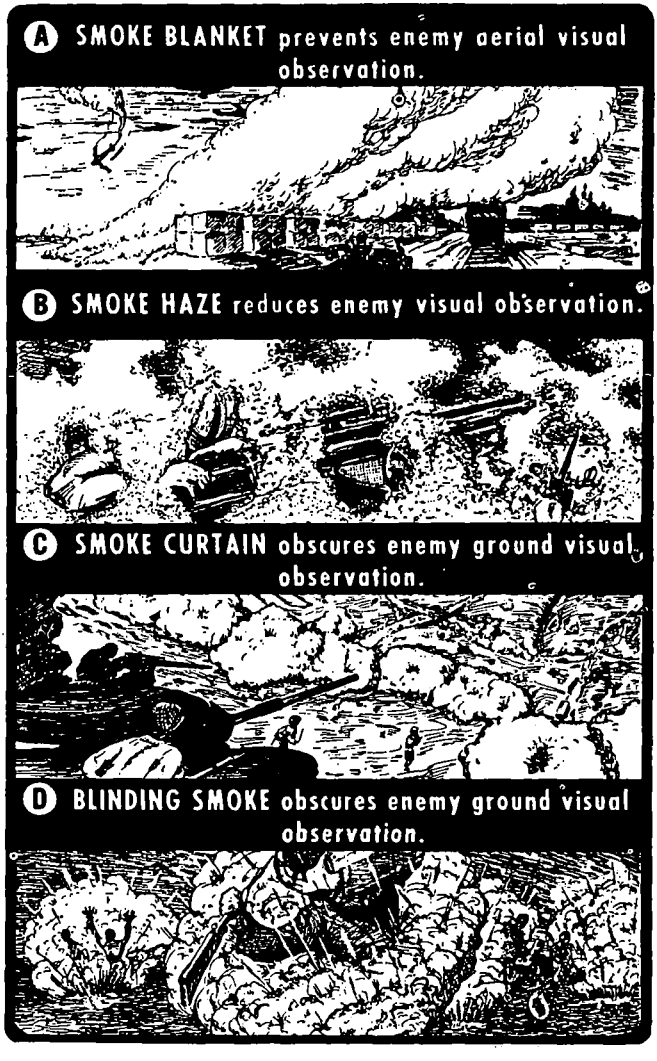


*Figure 5. Types of smoke screens.*

establishment and maintenance of a smoke screen varies with the type of smoke being used. Smoke is not generally effective in wind speeds above 17 knots, because strong winds disperse smoke clouds rapidly.

(1) HC smoke is most effective at wind speeds from 5 to 13 knots. In wind speeds below 5 knots, HC smoke drifts too slowly and rises too high to be effective.

(2) WP smoke is most effective at wind speeds from 9 to 17 knots. In wind speeds below 9 knots, WP smoke pillars excessively, whereas PWP smoke does not.

(3) SGF smoke is most effective in wind speeds from 5 to 11 knots. In wind speeds below 5 knots, it is difficult to produce a smoke screen of any appreciable depth.

*b. Wind Direction.* Wind direction influences the location of emplaced smoke generators and of the impact area for projected smoke. Since no long-range forecast of local winds is entirely reliable, smoke operation plans must provide for coverage in all wind directions. When WP is used for blinding or casualty effect, the rounds are impacted directly on the target regardless of wind direction.

*c. Air Stability.* Smoke clouds are affected by temperature gradient conditions as described in paragraph 21. In general, smoke can be used effectively under all but extreme conditions of air stability.

*d. Humidity.* The obscuring power and persistency of smoke are generally most effective under conditions of high humidity.

## 52. Effects of Terrain

In general, smoke clouds are affected by terrain as described in paragraphs 25 through 28. Although level, unbroken terrain is the most favorable for smoke screens, smoke can be employed on any type of terrain. On flat, unbroken terrain, smoke takes longer to spread out and merge than on rough terrain. Structures and terrain variations tend to disperse smoke, causing it to cover a larger area and to create a more uniform smoke screen. Smoke tends to be evenly dispersed in wooded areas and remains longer in woods than in the open. Very rugged terrain, consisting of large hills, breaks up smoke and causes holes in the smoke screen.

## 53. Methods of Dissemination

The selection of the best method for disseminating smoke for a particular operation is influenced by the tactical situation, desired results, conditions of weather and terrain, and availability of smoke munitions.

*a. Coverage in Friendly Territory.* Large-area smoke coverage in friendly territory is best accomplished by the use of mechanical smoke generators.

*b. Coverage in Enemy Territory.* Small-area smoke coverage in enemy territory is best achieved by the use of PWP and HC projected by mortars, artillery, or rockets. The antipersonnel qualities of WP and PWP produce a bonus effect. High performance aircraft and Army aircraft with smoke tanks are capable of laying smoke screens quickly and accurately in enemy territory.

## 54. Employment of Smoke in Friendly Areas

In friendly areas smoke may be used to deny information to the enemy by preventing observation and to deceive the enemy by drawing attention to nonvital areas. Figure 6 shows smoke used to support a river crossing. Smoke is also used to conceal gun flashes, artillery positions, construction sites, main supply routes, troop maneuvers, and other activities in the attack or defense.

*a. Dummy Screens.* A primary use of smoke is to assist in achieving combat deception. By use of a smoke screen to draw attention to an unimportant area, the enemy may be induced to attack that area and to expend ammunition with no commensurate gain or advantage.

*b. Protection of Rear Areas.* Smoke may be effectively employed in defense of vital installations to minimize personnel casualties and to minimize damage or destruction of materiel from low level attacks by enemy aircraft. Although smoke will not affect enemy precision radar bombing from high altitudes, it will have an adverse effect on enemy air attacks when aircraft are flown close to the ground to avoid early detection by radar. The use of dummy screens for deception is desirable, in addition to the use of a smoke screen to cover the installation to be protected.

*c. Coordination.* The use of smoke for extensive screening operations requires staff coordination and supervision to insure that the screen is effective and to minimize interference with friendly operations. The highest tactical commander concerned with an

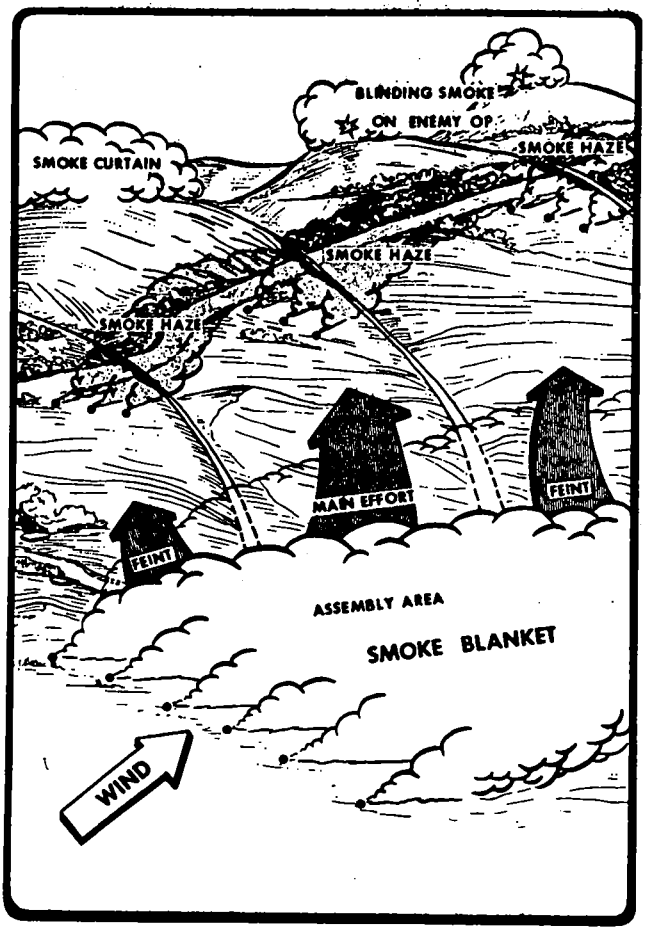


*Figure 6. Smoke used to support a river crossing.*

operation must be kept informed of smoke operations so that the overall effect of the smoke on his mission can be properly evaluated and exploited. Friendly forces must be notified of the use of smoke so that they can plan to take maximum advantage of the concealment afforded and can be prepared for possible interference of the smoke. The use of smoke by a tactical unit requires coordination at higher levels only when there is a possibility of the smoke being effective outside the zone of operations of the unit.

### 55. Employment of Smoke in Enemy Areas

Smoke may be used in enemy areas to blind hostile observation, to reduce the effectiveness of aimed fire, to mark targets for attack, to designate bomb safety lines, and for signaling purposes.

## Section III. EMPLOYMENT OF FLAME AND INCENDIARIES

### 56. General

Flame is used in combat to exploit man's natural fear of fire, to cause personnel casualties in inclosed places, to destroy camouflage or vegetation, or to decontaminate areas in which toxic chemical agents have been employed. Destruction of materiel is not a primary use for flame and should be considered as a bonus. Incendiaries are used primarily for destruction of materiel.

*a. Flame Weapons.* Fire bombs delivered by aircraft and ground flame weapons are antipersonnel, special-purpose munitions.

*b. Incendiary Munitions.* Materiel-destruction incendiaries can be positioned by troops. Air-delivered incendiary munitions may be employed to destroy vital targets.

### 57. Characteristics of Flame and Incendiaries

*a. Flame.* The characteristics of flame vary with the consistency of the fuel used. Thickened fuel can be projected from a flame thrower to a greater range than can unthickened fuel. Thickened fuel burns longer on the target, burns on water, clings to the target, and in some instances can be ricocheted around a corner into an otherwise inaccessible target. However, unthickened fuel can envelop a larger target; since it burns faster than thickened fuel, it can produce a greater asphyxiating effect.

*b. Incendiaries.* Incendiaries produce an intensive localized heat. They are used to start fires and to render unserviceable nonflammable materiel such as abandoned weapons.

### 58. Effects of Weather and Terrain

Wind is the most significant weather factor affecting the employment of flame. Weather has little effect on incendiaries. Terrain has little effect on flame or incendiaries.

*a. Wind.* Flame from flame throwers is easily influenced by wind direction and speed. A strong wind will affect the range and deflection of the flame rod and may break it up before the flame reaches the target.

*b. Precipitation.* Precipitation decreases the incen-

diary effect of flame on the target. Fuel floats on water and continues to burn effectively.

*c. Terrain.* Cover provided by terrain irregularities or man-made features may interfere with the placement of flame on the target.

### 59. Methods of Delivery

Flame can be delivered by ground or air means. Fire bombs are the primary flame weapons delivered by aircraft to support ground operations. Ground weapons and munitions that can be used to deliver flame include:

*a. Portable and Vehicle-Mounted Flame Throwers.* Flame throwers can project flame toward a target in a single burst or a series of bursts. The range varies with the type and consistency of the fuel, wind direction and speed, applied pressure, and size of the dispersing nozzle. The duration of each burst can be controlled by the gunner. The accuracy of the projected rod of flame is dependent on the consistency of the fuel mixture, on the wind, and on the experience of the gunner.

*b. Flame Field Expedients* (FM 20–33). Flame field expedients consist of improvised containers filled with fuel and of other materials generally available in the field such as explosives, fuzes, and grenades. Flame field expedients include but are not limited to—

(1) The flame land mine, an improvised 5- to 55-gallon drum or other container. These mines can be wired for controlled, trip-wire, or boobytrapped firing.

(2) The flame fougasse, a variation of the flame

land mine, in which the burning fuel is projected over a preselected area.

(3) The flame illuminator, an expedient such as the Husch flare for limited battlefield illumination.

### 60. Employment of Flame in Friendly Areas

Flame land mines and other flame field expedients are used in both offensive operations and defensive operations, but they are used chiefly in defensive operations. They can be used alone or to supplement other type minefields for casualty effect and for battlefield illumination. They can be employed along the edges of an integrated HE-chemical minefield, used to supplement explosive demolitions or as artificial obstacles, or used by security forces forward of the battle position to warn of enemy approach at night. Flame field expedients are used to—

*a. Warn of Enemy Approach.* They are used in defiladed areas or during periods of limited visibility.

*b. Produce Casualties.* The radiant heat of the fire ball, fragments of the container, and spattering of the burning fuel will cause casualties.

*c. Deter the Enemy by Psychological Effect.* The sudden appearance of flame from flame field expedients, as well as from flame throwers, is effective against mass enemy attacks.

### 61. Employment of Flame in Enemy Areas

The portable flame thrower is a close-range assault weapon employed principally in the offense. It is often used to assist infantry units in crossing the last

few critical meters to the objective. Flame throwers are employed to—

*a. Kill or Disable Enemy Troops.* Flame is projected directly on personnel either in the open or through openings in fortifications or armored vehicles. Personnel become casualties by heat injury associated with burning or by suffocation due to depletion of the oxygen supply if the target is a closed space such as a cave or pillbox.

*b. Demoralize Personnel.* Flame is projected toward personnel in caves, fortified bunkers, pillboxes, immobilized tanks, buildings, ditches, and trenches to demoralize through man's natural fear of uncontrolled fire.

*c. Assist in Clearing Areas.* Flame can be used to burn camouflage, vegetation, and other flammable materials. It can be used to expose camouflaged enemy emplacements and minefields. It may be used to assist in decontaminating lanes through areas contaminated with toxic chemical agents.

# CHAPTER 5

# CHEMICAL OPERATIONS

## Section I. INTRODUCTION

### 62. General

Toxic chemical agents are employed tactically to assist the field commander in accomplishing his mission. Choice of the chemical agent to be used depends on the commander's mission, objective, and plan of operations; the weather and terrain; the effects desired; the availability of the agent and munitions; and how soon friendly troops may occupy the target area. The employment of any toxic chemical agent requires staff consideration of the capabilities of available weapons for delivering the agent, ammunition requirements, and troop and civilian safety.

### 63. Tactical Objectives

Plans for the employment of toxic chemical agents are integrated into the scheme of operations. Possible tactical objectives of toxic chemical attacks are to—

*a. Soften Enemy Positions.* Toxic chemical agents are used against strongly defended enemy positions to weaken them by producing casualties among defending enemy troops.

*b. Hinder Support of Enemy Operations.* Toxic

chemical agents are used to produce casualties among enemy troops in reserve and in assembly or concentration areas. These agents are also used on enemy artillery, mortar, and missile positions; logistical installations; and observation posts to cause casualties and to restrict their use or to force their evacuation. Chemical interdictory fires restrict enemy operations by producing casualties, limiting the use of terrain and facilities, and requiring prolonged wearing of the mask. Contamination of damaged facilities delays repairs by forcing personnel to wear protective clothing and masks as they work.

*c. Produce Casualties with Minimum Destruction of Key Facilities.* Key facilities earmarked for future use by friendly forces can be attacked with toxic chemical agents to keep destruction to a minimum. Casualties to key enemy personnel may prevent damage to or destruction of the facility to prevent its use.

*d. Hinder or Canalize Enemy Movements.* Toxic chemical agents can be used to reinforce natural barriers or obstacles to hinder or canalize the enemy advance. Liquid chemical contamination used to reinforce a minefield or obstacle complicates the clearing operations and slows the breaching operations in minefields, and delays the repairing of damaged facilities and materiel.

*e. Assist in Isolating Enemy Positions.* Toxic chemical agents can be used to contaminate enemy routes of supply and reinforcement and thus assist in isolating enemy positions. Contamination of these targets must be planned and coordinated with the maneuver of friendly forces.

*f. Assist in Protection of Flanks.* Toxic chemical agents can be employed to contaminate selected terrain and thus hamper enemy operations against an exposed flank. This use of contamination forces the enemy to either avoid the contaminated area or cross the area and accept the risk of casualties.

### 64. Tactical Planning

Fundamental factors that are considered when the employment of toxic chemical agents is planned and the sequence in which these factors may be considered in the tactical operations center of a command are—

*a. Selection of Targets.* The selection of targets for attack with toxic chemical agents requires coordination of reconnaissance, intelligence studies, and staff evaluation of enemy targets and areas suspected of containing remunerative targets. Personnel targets that are vulnerable to or appropriate for chemical attack are normally selected.

*b. Effects Desired.* Before a toxic chemical agent is selected for use against a designated target, the effects desired must be determined. The tactical situation may require—

(1) Immediate effects, delayed effects, or the threat of continued casualty effects against enemy troops.

(2) Restriction of enemy use of terrain or materiel for specified periods of time.

(3) Restriction of enemy use of important installations without destroying them, so that they might be used by friendly forces.

(4) Neutralization of enemy fortifications that are not vulnerable to conventional high explosives or are not appropriate for attack by nuclear weapons.

*c. Selection of Toxic Chemical Agent.* The toxic chemical agent that will accomplish the effects desired is selected for employment against the designated target. Consideration is given to—

(1) The quality and type of protection available to enemy troops.

(2) The state of enemy chemical defensive training and morale.

(3) Probable enemy psychological reactions.

(4) The enemy chemical attack warning system.

(5) Enemy chemical agent detection and identification equipment.

(6) The weather and terrain of the battlefield.

(7) Capabilities and limitations of friendly toxic chemical agents.

*d. Selection of Weapons.* The weapons that can most effectively deliver the designated toxic chemical agent to the target are selected. In recommending the delivery means, consideration is given to the capabilities and availability of chemical ammunition for the weapons. It may be necessary to mass available weapons to obtain coverage of a large target area.

*e. Troop Safety.* Troop safety requirements are determined and disseminated to troop units concerned. These include estimated downwind hazard distances and data on contaminated areas.

### 65. Coordination

The employment of toxic chemical agents in a tactical operation must be closely coordinated with other current operations and with operations of adjacent friendly forces. Contamination of terrain essential to future planned operations is generally avoided. A chemical attack that may result in toxic clouds crossing unit boundaries downwind must be coordinated with the unit affected and must be approved by the next higher command. The employment of toxic chemical agents is normally coordinated at division or higher level but, in special situations, this responsibility may be delegated to subordinate units.

## Section II. FIRE SUPPORT PLANNING

### 66. General

The general plan for the employment of toxic chemical agents to support tactical operations is integrated with the unit scheme of maneuver. Once a general operational plan is approved, the fire support element of the tactical operations center develops a detailed fire support plan, which becomes an annex to the operations order. In the fire support plan, chemical fires are integrated with other fires. Alternate plans are made to provide for unfavorable meteorological conditions and changes in the tactical situation.

### 67. The Chemical, Biological, and Radiological Element (CBRE)

The chemical, biological, and radiological element

(CBRE) of the tactical operations center (TOC) or the chemical, biological, and radiological center (CBRC) performs the chemical target analysis and coordinates chemical fire support planning with the fire support element (FSE) and the fire support coordination center (FSCC) respectively. See TM 3–200 and FM 101–5 for details.

### 68. Chemical Target Analysis

When toxic chemical agents are used against area targets, the capabilities of available delivery means and munitions may limit the target coverage. Toxic chemical agents are not appropriate for all targets under all conditions. When properly used on selected targets and combined with other fires, toxic chemical munitions contribute to tactical operations by providing a weapon more effective on the target than other weapons. The selection of the toxic chemical agent to be used and the weapon to deliver the agent are determined by target analysis. (See TM 3–200 for guidance on the detailed chemical target analysis.) The elements of a chemical target analysis are generally as follows:

*a. Mission.* The tactical mission of the command is the major consideration in determining the purpose of the chemical attack. The commander may specify targets to be attacked and the effects desired on the targets. More frequently, it will be necessary to make a rapid estimation of the situation to determine the most critical targets and the agent effect suited to the target.

*b. Target Characteristics.* Characteristics of a target that must be considered are the size and shape,

location, type and approximate density of troops, degree of protection provided by fortifications and shelters, type of terrain, chemical protective equipment available to troops, predicted weather conditions, and proximity to friendly troops and civilians.

*c. Analysis.* The capabilities of attacking the target based on weapons and chemical munitions available are developed. Area contamination is considered in relation to its effects on current and future operations.

*d. Evaluation.* Effects of available toxic chemical agents on specific targets are evaluated. Political implications of the effects on civilian populations are coordinated with the civil affairs staff officer, in accordance with the theater commander's policies. The best technique and optimum time of chemical attack are determined.

*e. Recommendations.* Information furnished to the commander or the G3 to assist in making a decision includes the following:

(1) Location and type of targets for chemical attack.

(2) Toxic chemical agent to be used and effect desired.

(3) Fire support required.

(4) Time of attack.

(5) Limitations on total time to complete the attack.

(6) Troop and civilian safety measures.

(7) Coordination required.

## Section III. TROOP SAFETY

### 69. General

The use of toxic chemical agents may create hazards to friendly troops. These hazards are, generally, those created downwind of the target area and those within the target area through which friendly troops must pass. There is little risk involved to friendly troops with normal protection and adequate warning. However, the commander may be required to employ his troops in an area of hazard even though he is unable to warn all troops of the hazard. The command decision to accept a calculated risk is dependent upon the urgency of the tactical situation. The commander is advised of the probable effects of exposure to this hazard by the chemical officer and the medical officer.

### 70. Persistency Hazard

Troops crossing an area contaminated with toxic chemical agents are exposed to a hazard that varies in duration of effectiveness according to the amount and type of agent disseminated and the existing terrain and meteorological conditions. Casualties can result if troops enter the contaminated area on foot, unless they wear protective clothing and masks; unless lanes through the area have been decontaminated; or unless sufficient time has elapsed to permit weathering of the contamination.

### 71. Downwind Aerosol and Vapor Hazard

Clouds of toxic chemical aerosols and vapors travel downwind. If weather and terrain conditions are favorable, some toxic clouds may retain a potential

casualty effectiveness for several miles downwind from the point of release. (See par. 74 for safe downwind distance data.) Tactical considerations may require the commander to employ toxic chemical agents upwind of friendly troops. This employment may produce an area of hazard in which friendly troops are required to operate. Under these conditions and prior to the chemical attack, friendly troops are warned to take suitable protective measures.

*a. GB Vapor Hazard.* Because of the extreme toxicity of GB, the commander may decide the degree of risk that he will accept for friendly unwarned troops downwind of the target area. The following criteria may be used as a guide for establishing the degree of risk for exposure of unmasked friendly troops:

(1) Negligible risk—troops are safe.

(2) Moderate risk—anticipated levels of effects are tolerable or, at worst, a minor nuisance.

(3) Emergency risk—anticipated levels of effects may cause a few incapacitated casualties and may reduce the combat efficiency of the unit.

*b. HD Vapor Hazard.* The downwind travel of HD vapor (table I) is relatively small, except under unusually favorable meteorological conditions. When targets beyond the forward edge of the battle area (FEBA) are attacked with HD, the commander may normally be assured that there will be an acceptable downwind vapor risk to friendly unwarned troops. The following criteria may be used as a guide for establishing the degrees of risk for exposure of unmasked friendly troops:

(1) Negligible risk—troops are safe.

(2) Moderate risk—anticipated levels of effects are tolerable or, at worst, a minor nuisance.

(3) Emergency risk—anticipated levels of effects may cause a few delayed incapacitated casualties and may reduce the combat efficiency of the unit.

*c. VX Aerosol Hazard.* (Refer to TM 3–200A for guidance.)

### 72. Protective Measures

When toxic chemical agents are employed, the commander is responsible that appropriate protective measures are taken to insure the safety of friendly troops in the area of hazard. When practicable, key personnel down to company level are notified of the proposed chemical attack in time to permit checking of protective equipment. The following procedures are routine in small units: chemical detection devices are checked to insure that they function properly and that trained operators are available; individual protective masks are checked for facepiece or canister damage and for fit. If the tactical situation permits, the commander can require friendly troops to observe safe time intervals before they enter contaminated areas (par. 75) or to remain safe distances downwind of the target area (par. 74).

### 73. Traversing Deliberately Contaminated Terrain

When friendly troops are given the mission of crossing a chemically contaminated area, the commander decides whether or not lanes will be made safe through the area of hazard. Large-scale decontamination of contaminated areas in the vicinity

of the main battle position is not feasible. When time and the tactical situation permit, safe lanes may be made through a contaminated area, but the nature of the work involved may alert the enemy and cause friendly troops to lose the advantage of surprise. Troops wearing protective masks may safely cross deliberately contaminated areas in vehicles. Masked troops in full permeable protective clothing may traverse contaminated areas on foot with moderately low risk 3 or more hours after the initial contamination.

*a. Command Decision.* When the urgency of a tactical situation requires traversal of a contaminated area without making safe lanes, commanders may be required to direct their troops to traverse the contaminated area without wearing protective clothing. The number and severity of casualties that may be produced among troops crossing a contaminated area are influenced by the following factors:

(1) Nature and concentration of the contaminant.
(2) Presence of vegetation and type of terrain.
(3) Meteorological conditions.
(4) Depth and width of the contaminated terrain.
(5) Time spent in the area and opposition by the enemy to the crossing.
(6) Type of clothing worn by troops.
(7) Protective measures taken by troops before they enter the contaminated area.
(8) Personal decontamination measures taken by troops after they cross the contaminated area.

*b. Special Precautions Against G-Agents.* When

troops must traverse terrain contaminated with G-agents (par. 75*a*), they are instructed to take suitable precautions against the danger of G-agent vaporizing from contaminated clothing. Precautions may include keeping troops dispersed and out of inclosed places for at least 1 hour after exit from the contaminated area and may include decontaminating contaminated clothing and equipment.

*c. Special Precautions Against V-Agents* (TC 3–10). When troops must traverse terrain contaminated with V-agents, they are cautioned to avoid, to the extent possible, contact with the terrain and vegetation. Contaminated clothing and equipment must be decontaminated or removed.

### 74. Safe Downwind Distance Data

Toxic chemical agents present a vapor hazard to troops for a predictable distance downwind of a contaminated area. The downwind areas of hazard from toxic chemical agents are calculated and plotted on the situation map or operations overlay and are furnished to troop units likely to be exposed.

*a. GB Hazard Distance.* Refer to TM 3–200 for a method of estimating the downwind hazard from GB vapor and to paragraph 71 for the commander's criteria.

*b. HD Hazard Distance.* Refer to table I for an estimation of the downwind hazard from HD vapor and to paragraph 71 for the commander's criteria.

*c. VX Hazard Distance.* Refer to TM 3–200A for guidance on VX.

*Table I. Downwind Vapor Hazard from HD*

| Type of terrain [1] | Downwind dimension of target area (in meters) | Distance downwind of HD contaminated area that vapor hazard may exist (in meters) [2 3 4] | |
|---|---|---|---|
| | | Hot, humid weather (above 80°F) | Warm weather (60° to 80°F) |
| OPEN GRASSLAND | 200 | 900 | 1,600 |
| | 500 | 2,200 | 4,100 |
| BARREN SOIL OR SAND. | 200 | 1,100 | 2,100 |
| | 500 | 2,700 | 5,200 |

[1] For travel of HD clouds in wooded terrain, the above "open grassland" distances are multiplied by 0.5. (See par. 28 for an explanation of wooded terrain.)

[2] These distances apply only over relatively flat terrain, unobstructed by any breaks due to the presence of trees, houses, or abrupt changes of contour of the land.

[3] Distances are based on HD ammunition expenditures given in TM 3-200.

[4] Air stability conditions favorable to extensive downwind travel are rarely found at high temperatures, because the atmosphere under these conditions tends to diffuse and dissipate the toxic cloud before it has a chance to travel a considerable distance downwind of the target area.

## 75. Safe Time Data for Contaminated Areas

Toxic chemical agents are effective generally as a liquid and as a vapor against troops in a contaminated area for variable periods of time.

*a. Nerve Agent (GB and VX).* The hazard from liquid nerve agents is more lasting than the hazard from the vapor, especially in low terrain, shell craters, and foxholes. (See TM 3-200A for classified VX data.)

*Table II. Duration of Hazard in an HD-Contaminated Area* [1]

| Task | Type of terrain | Approximate time after contamination that prescribed tasks may be safely performed | | | |
|---|---|---|---|---|---|
| | | Wearing protective clothing and masks | | Not wearing protective clothing | |
| | | Weather | | | |
| | | Warm (60°–80° F) | Hot (above 80° F) | Warm (60°–80° F) | Hot (above 80° F) |
| TRAVERSAL [2] (Walking across area, 2 hr or less). | | | | Wearing masks [3] | |
| | Bare soil, sand, or short grass. | 0 | 0 | 36 hr | 36 hr |
| | Low vegetation..... | 4 hr | 2 hr | 36 hr | 36 hr |
| | High vegetation, including jungle and heavy woods. | 12 hr | 6 hr | 4 days | 2 days |
| ADVANCE UNDER FIRE (Contact with ground, 1 hr; total time in area, 2 hr). | | | | Not wearing masks [4] | |
| | Bare soil or low vegetation. | 24 hr | 8 hr | 3 days | 2 days |
| | High vegetation, including jungle and heavy woods. | 2 days | 24 hr | 6 days | 4 days |

| | | | | | |
|---|---|---|---|---|---|
| OCCUPATION (Without hitting ground, 24 hr). | Bare soil or low vegetation. | 1 hr | 1 hr | 4 days | 3 days |
| | High vegetation, including jungle and heavy woods. | 1 hr | 1 hr | 4 days | 3 days |
| OCCUPATION (Involving advance under fire, 24 hr). | Bare soil or low vegetation. | 24 hr | 8 hr | 4 days | 3 days |
| | High vegetation, including jungle and heavy woods. | 2 days | 24 hr | 6 days | 4 days |

[1] Contamination of the area is based on an average expenditure of from 240 to 1,200 pounds of HD per hectare.

[2] For men wearing protective clothing, when traversal is made in daylight and areas of heavy contamination can be avoided or decontaminated, the times can be reduced to about one-half of those given.

[3] For men walking in a contaminated area for 2 hours without protective clothing, the limiting factor is the vapor hazard. If the traversal requires only a few minutes, it can be accomplished at earlier times than those given.

[4] The approximate times at which troops could occupy areas without having to wear masks apply to men with or without protective clothing. The vapor hazard is the limiting factor.

(1) Liquid GB and VX remain in shell craters for extended periods of time, depending on weather and terrain characteristics. Friendly troops are advised to avoid craters in areas attacked with GB or VX until tests with detection devices indicate that a safe condition exists. No minimum safe time can be estimated for occupation of these contaminated craters by friendly unmasked troops, because the persistency of these liquid agents varies with many factors.

(2) GB vapor in the target area begins to dissipate immediately after a GB chemical attack. Troops designated to enter and occupy an area attacked with GB are directed to remain masked until tests indicate that casualty-producing concentrations of GB are no longer present. Low lying or wooded areas may retain GB vapor for even longer periods than would the remainder of the area.

(3) The safe entry time for troops into areas downwind of the target as well as the duration of exposure of troops in the path of the toxic cloud can be estimated by calculation of the time that it takes the toxic cloud to clear a designated area. Because of drag effect and other variables, the toxic cloud tends to lengthen as it moves downwind. A safety factor of 10 minutes must be added to the time-length of the toxic cloud to compensate for these variables. For example, when the wind speed is 9 knots (16 km per hr) and the downwind distance that the toxic

cloud travels is 1½ kilometers, at least 16 minutes (6 minutes cloud travel plus 10 minutes safety factor) must elapse before unmasked friendly troops could safely occupy the downwind area.

*b. Blister Agent (HD).* HD disseminated in a target area presents both a liquid hazard and a vapor hazard to friendly personnel, varying in time principally with weather conditions and with other factors indicated in table II.

## Section IV. NONPERSISTENT CHEMICAL ATTACK

### 76. General

Nonpersistent chemical attacks may be made alone against targets occupied by enemy troops, or they may be made to increase the effectiveness of other supporting fires. They are most effective when made to circumvent the enemy's protection against conventional high explosive munitions. A nonpersistent chemical attack is especially useful when a nuclear attack against a close-in target would create obstacles to friendly troop maneuver or would create friendly troop safety problems.

### 77. In Offensive Operations

Nonpersistent chemical attacks are made against targets occupied by enemy troops, including those in the path of the attacking forces. They are normally integrated into preparatory fires against known or suspected targets. GB can be used—

*a.* To produce casualties among enemy troops in the area selected for the penetration and to assist the

assaulting units in the initial breakthrough. GB may also be used against enemy reserves. When practicable, the nonpersistent chemical attack is so coordinated as to enable friendly troops to assault unmasked. However, enemy counterpreparation fires placed on the attacking forces may include toxic chemical agents that require friendly troops to mask.

*b.* To produce casualties in occupied targets or in those areas suspected of being occupied by enemy troops prior to the attack, under favorable weather conditions when the wind does not blow toxic clouds downwind toward friendly troops. Chemical attacks are particularly effective at night because of favorable meteorological conditions. Casualties may result among troops in the target area and in the path of the toxic cloud traveling downwind.

*c.* To deliberately harass enemy troops by intermittent chemical fires maintained over long periods of time. Sleep is thereby made more difficult, and the physical demands of wearing masks for long periods lower the morale and fighting ability of enemy troops.

### 78. In Defensive Operations

Nonpersistent chemical attacks are made against enemy troops at any time or place that they present a profitable target to produce casualties or to slow down the attack by forcing enemy troops to wear masks. Nonpersistent chemical attacks may be made against enemy troops concentrating for the attack, to support the forces along the FEBA or to assist the counterattack or striking force. GB can be used—

*a.* On targets in front of the FEBA prior to the time the enemy attack develops. Profitable targets are

known or suspected enemy troop concentrations of reserves, attack positions, command posts, and artillery positions.

*b.* At night against known or suspected troop concentrations to produce casualties in the target area and to harass extensive areas downwind. By proper selection of targets and time spacings of the chemical fires throughout the night, enemy troops can be subjected to casualty-producing concentrations or can be kept in masks under frequent alerts.

### 79. In Conjunction With Nuclear Attack

When a nonpersistent chemical attack is made in conjunction with a nuclear attack, the basic considerations for a nonpersistent chemical attack remain unchanged. The chemical attack follows the nuclear attack. A nonpersistent chemical attack may be made in conjunction with a nuclear attack to—

*a. Cause Casualties in the Buffer Zone of Close-In Nuclear Targets.* Because of troop safety requirements in a nuclear attack of close-in targets, it may be necessary to offset in depth the desired ground zero to avoid undue hazard to friendly troops. The radius of severe damage effects of the nuclear weapon selected may not cause significant casualties in the crust of enemy forces immediately opposing friendly forces to permit quick penetration of the enemy positions. GB can effectively be employed in this buffer zone to help friendly troops through this initial crust of resistance if wind conditions permit or if the commander is willing to conduct initial phases of the attack with masked troops.

*b. Cause Casualties Without Creation of Obstacles.* The use of nuclear weapons in wooded or built-up areas

may create obstacles to movement of friendly forces because of tree blowdown in forests or creation of rubble in cities. GB can be employed in designated areas without causing obstacles to movement.

*c. Cause Casualties Without Contamination.* Most nuclear detonations that are tactically successful (with a height of burst low enough to achieve significant target effect) create an area of neutron-induced gamma contamination. The radius of hazard of this induced contamination approaches the radius of effects for severe damage to dug-in troops. Thus, the maneuver of foot troops may be restricted to the area outside the radius of severe damage effects of the weapons used. Mounted troops are not so restricted provided the area is relatively open so that any obstacles from tree blowdown and rubble of built-up areas can be avoided. When plans are made for the use of nuclear weapons to support an attack, selected ground zeros are normally sufficiently separated to leave a path that is free of induced contamination and obstacles to movement for attacking forces. Thus, the attacking forces may still be faced with the resistance of enemy forces in the path of attack. Enemy forces may not have suffered severe casualties from the nuclear bursts to either flank, although considerable disorganization can be expected. GB can be effectively employed in this area to capitalize on the disorganization and shock of enemy troops resulting from the nuclear strikes, with promise of a high casualty level. The nonpersistent chemical attack is made very soon after the nuclear attack to achieve surprise effects before control and discipline are reestablished.

## Section V. PERSISTENT CHEMICAL ATTACK

### 80. General

Persistent chemical attacks can be made against targets occupied or unoccupied by enemy troops. Under favorable weather conditions, a persistent chemical attack can produce delayed casualties among masked enemy troops.

### 81. Offensive Operations

Persistent chemical attacks are made on target areas that friendly forces do not intend to enter immediately, because the resulting contamination restricts maneuver of foot troops. HD or VX may be used to help protect the flanks of the attacking forces. Persistent chemical attacks are especially effective when made against enemy reserves. These chemical attacks can contaminate alternate defensive positions in an attempt to fix the enemy in preselected uncontaminated positions for attack with other weapons. Persistent chemical attacks can neutralize enemy observation posts and artillery positions.

### 82. Defensive Operations

Persistent chemical attacks are made to contaminate terrain that is important to the enemy scheme of maneuver, such as avenues of approach, key terrain features, artillery positions, and assembly areas. Persistent chemical attacks have special defensive value, since contamination established before the enemy attack may remain effective throughout the attack. Contaminated terrain hampers attacking enemy troops by forcing them to wear protective clothing and equipment or to take a calculated risk in traversing the

contaminated area without protective clothing. Persistent chemical attacks can contaminate critical targets that have been damaged by high explosives or nuclear weapons, thereby delaying repairs. Persistent chemical attacks can be used to canalize enemy attacks along avenues of approach favorable to the defender and to compel the enemy to move into areas that facilitate friendly counterattack. Persistent chemical attacks can also be used to cover gaps between friendly units and to protect flanks, especially when friendly forces are deployed over wide frontages. Terrain contaminated with toxic chemical agents may be periodically recontaminated in order to effectively restrict enemy use of the terrain for appreciable periods of time.

### 83. Chemical Minefields and Barriers

Chemical land mines are designed to restrict effective enemy use of selected terrain, to further delay minefield breaching operations, and to inflict casualties on persons crossing the mined area. When authorized, toxic chemical mines may be employed to provide a chemical minefield or barrier; they may be used with high explosive mines to form an integrated HE-chemical minefield. Either use must contribute to the overall defensive plan.

*a. Chemical Minefields.* Chemical mines may be used to contaminate key terrain features, obstacles, and demolished facilities and bridge approaches. When used for primary toxic effects, chemical minefields are activated by deliberate simultaneous detonation of all or major parts of the minefield. The M1 chemical land mine filled with HD is designed for simultaneous deto-

nation; the M23 chemical landmine filled with VX can be modified for this use. For maximum effects, chemical minefields are detonated just prior to the entry of enemy troops into the mined area. The authority to detonate chemical minefields is delegated to the lowest echelon responsible for defending the mined area.

*b. HE-Chemical Minefields.* Integrated HE-chemical minefields normally are a part of the division (or higher) defensive plan. These minefields are most effective when contact-activated chemical mines are used. The M23 chemical landmine filled with VX is designed for contact activation and may be fitted with antilift devices. Chemical mines are integrated into the HE minefields in a nonuniform pattern. The recommended ratio for use is one chemical mine in approximately every fourth cluster of HE mines. The use of HE mines reduces crossing speed, thereby forcing ground exposure to contaminated terrain from activated chemical mines. Chemical mines slow breaching operations by discouraging use of explosive rapid mine-clearing devices that would cause chemical contamination of the area. Integration of chemical mines into existing HE minefields is accomplished by adding rows of chemical mines or both chemical and HE mine clusters to the edges of the existing minefield, *not* by reentering the existing minefield.

*c. Employment of Chemical Mines.* Normally, chemical mines are not employed in protective or defensive minefields except those intended to be integrated into a barrier system. Chemical mines are particularly suitable for employment in barrier minefields; they can be authorized for use by division commanders,

subject to policy restrictions of the theater commander. (See FM 20–32 for additional information on the employment of land mines.)

*d. Troop Safety.* When wind conditions are unfavorable, the responsible commander must take appropriate troop safety measures for friendly troops prior to the simultaneous detonation of large numbers of chemical mines. Detonation of a chemical minefield close to friendly troops, under adverse wind conditions, can result in downwind aerosol or vapor hazard to troops. Contact-activated chemical mines are not expected to create a significant downwind hazard, since only small groups or single mines are likely to be detonated at any one time.

### 84. Breaching Integrated Minefields

Integrated enemy HE-chemical minefields are not permitted to canalize or slow up the advance of attacking friendly forces. After the initial use of toxic chemical agents is authorized, troops who are detailed to breach a minefield wear permeable protective clothing (normal combat clothing impregnated with chemicals) and carry protective masks and gloves ready to be put on quickly to minimize the effects of chemical mine explosions. Complete impermeable protective clothing and masks are worn by troops detailed to breach a contaminated area or any minefield contaminated by mechanical or explosive means. Since minefields are normally covered by fires of supporting weapons, these weapons are first neutralized, and then the barrier is rapidly breached and crossed, by use of vehicles when available.

## Section VI. SPECIAL CHEMICAL OPERATIONS

### 85. General

The doctrine for the employment of toxic chemical agents to support offensive and defensive operations applies generally to special operations. Modification of this doctrine may be required in the following special operations because of the characteristics of the area of operations, the nature of the special operations, special conditions under which the operations are conducted, or a combination of these factors. (See FM 100–5, FM 60–5, and the list of 30-, 31- and 57-series field manuals in app. I for doctrine pertaining to specific special operations.)

### 86. Attack of a Fortified Position

If isolation of a fortified position by an envelopment is not possible, reduction of a fortified position by a direct attack against a weak spot in the fortifications may be necessary. (See FM 31–50 for doctrinal guidance.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks are effective against troops in hostile fortifications not protected by filtration equipment. GB munitions near the target project a portion of the toxic cloud into the fortifications. Direct hits are not required. When intelligence on the exact location of individual fortifications within a fortified area is inadequate, nonpersistent chemical attacks are made on the entire fortified area. Individual, well-located fortifications are attacked as point targets.

*b. Persistent Chemical Attack.* Persistent chemical attacks are effective against flanking and reserve posi-

tions from which enemy counterattacks could be launched. These chemical attacks can also be made against enemy strong points that are bypassed and need not be occupied by friendly forces immediately. Troop safety conditions, particularly downwind vapor hazard and the presence of persistent contamination, must be evaluated before a persistent chemical attack is made.

### 87. River Crossings and Defense of a River Line

The attack across an unfordable river requires special technical and tactical preparations proportionate to the size of the river and the relative strength of the opposing forces. Chemical troop units and special equipment may be necessary. Alternate plans for chemical attack are prepared to provide for changes in the weather and the tactical situation. (See FM 31–60 for doctrinal guidance on river crossings.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks are effective against enemy troops concentrating for a river crossing.

*b. Persistent Chemical Attack.* Persistent chemical attacks against logical enemy crossing sites can delay and interfere with an enemy attempt to cross a river.

### 88. Combat at Night

Night combat is characterized by a decrease in effectiveness of aimed fire and an increase in the difficulties of movement, observation, communication, and security. Fog or smoke produces conditions similar to those produced by darkness. Toxic chemical agents can be employed to compensate for the decrease of effectiveness of aimed fire by the coverage of selected enemy-held areas. However, chemical fires are planned

on the basis of daylight reconnaissance and observation. Toxic chemical agents are most effective at night because of normally stable meteorlogical conditions.

*a. Nonpersistent Chemical Attack.* When GB is used in night attacks on targets that pose a friendly troop safety problem, the nonpersistent chemical attack is made well ahead of the time attacking friendly forces enter the target area so that the hazards are largely dissipated by that time. Deep targets beyond the objective, such as reserves, are good targets provided that wind direction is favorable or targets are beyond the range of hazardous downwind cloud travel for friendly troops.

*b. Persistent Chemical Attack.* Persistent chemical attacks are made with caution, because contaminated areas are more difficult for friendly troops to avoid or to traverse at night than in daylight.

### 89. Combat in Woods and Built-Up Areas

Combat in woods, like combat in towns, is characterized by difficulty in observation and in control of troops, by reduced effectiveness of aimed fire, and by increased importance of close combat.

*a. Nonpersistent Chemical Attack.* Because cover and concealment afforded by woods and built-up areas make target acquisition difficult, the area coverage capabilities of a nonpersistent chemical attack take on increased importance.

*b. Persistent Chemical Attack.* The persistency of toxic chemical agents is increased in woods.

### 90. Mountain Operations

Mountain operations are characterized by terrain that retards and restricts mobility and by heights that

dominate valleys and lines of communication by observation and fire. Bunkers, caves, and prepared positions on reverse slopes can provide excellent cover to the defender, are almost completely invulnerable to high explosives, and are somewhat invulnerable to nuclear attack. (See FM 31–72 for doctrinal guidance on mountain operations.)

*a. Effects of Weather and Terrain.* Terrain and weather influence the use of toxic chemical agents in mountain areas. Prevailing winds in the area are altered by local wind currents along the valleys and by air currents and air movements up or down the mountain slopes. Prediction of the direction and the extent of cloud travel is difficult and requires knowledge of local conditions. Chemical clouds are funneled along the valleys, with higher vapor concentrations along the valley floor than on the slopes.

*b. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks are more effective than high explosives against well dug-in positions. Toxic chemical clouds can penetrate caves and bunkers.

*c. Persistent Chemical Attack.* Persistent chemical attacks are made to contaminate critical targets such as fortifications, artillery and reserve positions, and command posts.

### 91. Combat at Defiles

Combat at defiles is characterized by troops canalized through a relatively narrow space, with obstacles on either side creating the defile. Space for maneuver is limited, and the presence or absence of obstacles and of chemical contamination has an abnormal influence on the success of operations.

*a. Nonpersistent Chemical Attack.* In offensive operations, nonpersistent chemical attacks are effective in the zone of penetration against enemy troops defending the defile in force when nuclear attacks would create unacceptable obstacles from contamination or tree blowdown. In defensive operations when friendly forces are disposed on the high ground to the flanks which command the defile, nonpersistent chemical attacks are effective against enemy troops in valleys and similar low terrain.

*b. Persistent Chemical Attack.* In offensive operations, persistent chemical attacks are made against occupied positions and key terrain to the flanks of the defile and on likely avenues of approach for enemy counterattacks.

### 92. Combat in Snow and Extreme Cold

Combat in snow and extreme cold is characterized by many problems such as the retention of warmth in personnel. Shelter and other installations necessary for the conduct of operations are of critical importance. Although special preparations, equipment, and techniques of employment may be required, toxic chemical agents may be employed to support offensive and defensive operations. Some toxic chemical agents present a storage problem in extreme cold. When used in deep snow, impact-detonating chemical ammunition buries in the snow and the chemical agent tends to be smothered. Chemical ammunition produces less vapor because of low temperatures and the smothering effect of the snow. On the other hand, low temperatures increase the persistency of toxic chemical agents in both vapor form and liquid form. Low temperatures reduce masking efficiency, which makes necessary an

efficient chemical alarm and alert system. The difficulties of movement and supply reduce the amount of artillery available. Greater reliance may therefore be placed on air delivery of toxic chemical agents in arctic operations than in operations elsewhere. (See FM 31–71 for doctrinal guidance on operations in the arctic.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks are preferable against enemy troops in shelters and fortifications that friendly troops may require for protection against extreme cold. Artillery is normally concentrated against individual targets rather than against area targets. Nonpersistent chemical attacks are also preferable to high explosive and nuclear attacks against facilities that friendly forces intend to occupy and use. GB stays clost to terrain surfaces in extreme cold and may be adsorbed onto cold weather clothing. The GB may later vaporize in heated shelters and vehicles and cause casualties.

*b. Persistent Chemical Attack.* The persistency of VX is increased in cold weather. VX may be useful in contaminating ice and snow used as a source of water supply. Persistent chemical attacks have limited usefulness because thick arctic clothing prevents the liquid agent from reaching the skin of troops.

### 93. Jungle Operations

Jungle operations are characterized by difficulty in observation and supporting fires. Climatic conditions have a profound influence in jungle operations. The hot, humid climate, coupled with the blazing sun and tropical downpours, must be considered in the employment of toxic chemical agents. Wind speed and turbu-

lence are low in jungles, thereby increasing the persistency of toxic clouds. (See FM 31–30 for doctrinal guidance on jungle operations.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks are effective against enemy troops in strong defensive positions that are difficult to destroy with high explosives. Because jungle operations are necessarily slow and deliberate, time is usually available for long preparatory nonpersistent chemical fires in offensive operations. Air delivery of toxic chemical agents is effective and, frequently, is the only means available for the attack of targets.

*b. Persistent Chemical Attack.* In defensive operations, the enemy's avenues of approach to friendly positions are blocked with barriers and obstructions. Persistent chemical attacks are made against these barriers to hinder the advance of hostile troops. When the approach of enemy forces is canalized by a scarcity of trails, chemical land mines are integrated into the defensive barrier system.

### 94. Desert Operations

Desert operations are characterized by limited vegetation and water sources, extreme variation in temperature, and dependence of operations on supply, particularly water supply. Special equipment and training are required for desert operations. Opportunities for extensive use of toxic chemical agents are generally limited. Toxic chemical agents present storage problems because of the extremes in temperature between daytime and nighttime. Extreme lapse conditions during the daytime dissipate toxic clouds quickly and require high ammunition expenditures.

(See FM 31–25 for doctrinal guidance on desert operations.)

*a. Nonpersistent Chemical Attack.* Effective nonpersistent chemical attacks are generally limited to nighttime when inversion conditions exist.

*b. Persistent Chemical Attack.* Effective persistent chemical attacks with HD are limited because of high ammunition requirements and rapid dissipation of the liquid agent from the ground.

### 95. Guerrilla and Counterguerrilla Operations

*a. Guerrilla Operations.* Guerrilla operations are characterized by small semiindependent forces operating against greatly superior enemy forces in any type of terrain from mountains to jungles. Special arms, equipment, and methods of operations are frequently necessary. The tactics used—small units striking quick surprise blows against enemy units, convoys, or supply trains and avoiding large-scale operations—favor the small-scale use of toxic chemical agents. Supply, storage, and transportation are problems associated with the employment of toxic chemical agents in guerrilla operations. (See FM 31–21 for doctrinal guidance on guerrilla operations.)

*b. Counterguerrilla Operations.* Toxic chemical agents can be employed in counterguerrilla operations. These operations usually occur in mountainous, heavily forested, jungle, and sparsely settled areas. When guerrillas are operating in areas occupied by friendly civilians, irritant chemical agents are used.

### 96. Amphibious Operations

Joint amphibious operations present many technical and tactical problems that require special organiza-

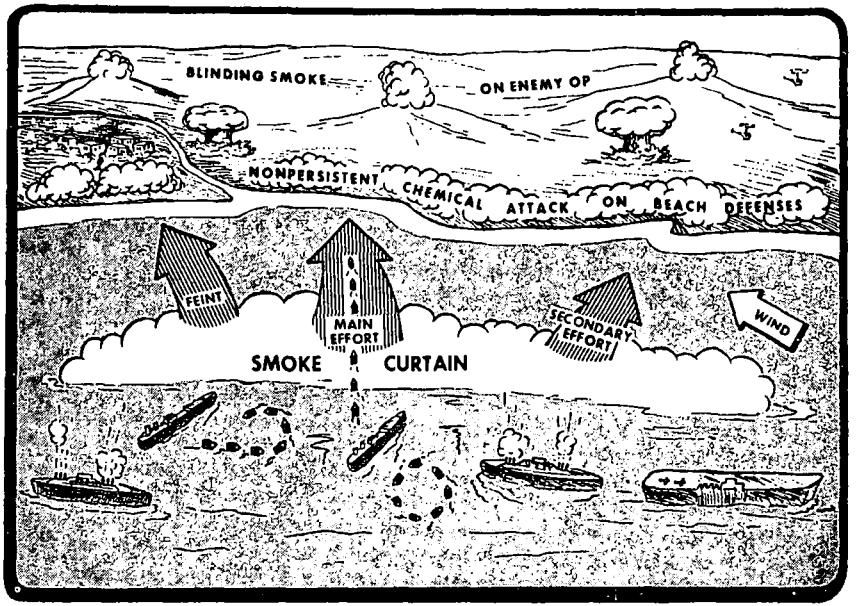


*Figure 7. Nonpersistent chemical attack to support an amphibious landing.*

tion, equipment, and methods of operations. Plans for the employment of toxic chemical agents to support an amphibious landing are developed concurrently and are integrated with the overall fire support plan. Chemical attacks against selected targets support prelanding operations designed to facilitate the assault landing. Chemical attacks against beach fortifications immediately preceding the assault landing reduce casualties among assaulting troops (fig. 7). The Air Force and the Navy furnish the chemical fire support immediately before and during the assault landing. (See FM 60–5 for doctrinal guidance on amphibious operations.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks (fig. 7) are made against enemy troops in strong defensive positions that are resistant to high explosives. An onshore or flanking wind is desirable to minimize hazards to friendly troops.

*b. Persistent Chemical Attack.* Persistent chemical attacks are made to contaminate vital transportation facilities, such as demolished bridges, and thus assist in isolating the beachhead from reinforcement by hostile reserves. Consideration must be given to road net requirements of friendly forces designated to move inland and establish beachhead defenses.

### 97. Airborne Operations

Airborne, operations, like amphibious operations, present many technical and tactical problems that require special organization, equipment and methods of operation. Plans for the employment of toxic chemical agents to support an airborne operation are developed concurrently and are integrated with the overall fire

support plan. These plans vary with the nature of the landing plan and with the proposed ground tactical plan. (See FM 57–30 and FM 57–35 for doctrinal guidance on airborne operations.)

*a. Nonpersistent Chemical Attack.* Nonpersistent chemical attacks can be made against selected targets in the objective area prior to the airborne assault and, subsequently, to support ground operations in this area. The chemical attacks to support the airborne assault are so timed that the toxic clouds clear the drop/landing zones just prior to the assault. Primary relianee for chemical attacks during the initial phases of the operation is on the Air Force, although rockets can be employed by ground forces within range. The reduced quantity and caliber of ground fire support weapons initially taken into the objective area limit the chemical attack capabilities of assault troops. Nonpersistent chemical attacks are effective against targets in or adjacent to the landing zones when casualties are desired without the obstacles or destruction resulting from the employment of high explosives or nuclear weapons.

*b. Persistent Chemical Attack.* Persistent chemical attacks are not normally made against targets in the landing zones because of the delayed casualty effect and possible interference with friendly maneuvers. However, to assist friendly forces in their defense of the objective area, which they do not plan to occupy, toxic chemical agents can be used to contaminate avenues of approach, dominating terrain, or other key terrain features.

# CHAPTER 6

# BIOLOGICAL OPERATIONS

## Section I. INTRODUCTION

### 98. General

Biological agents are living organisms or their toxic products that can cause disease in susceptible humans or animals or damage to crops. Biological agents are classified into three main groups: antipersonnel, antianimal, and anticrop. Although the agents have varying effects and act on different targets, man must be considered the primary objective of biological agent employment. (Refer to TC 3–7 for classification information on antipersonnel biological agents and munitions and to TM 3–216 for unclassified information on antianimal and anticrop agents.)

*a. Antipersonnel Biological Agents.* Antipersonnel agents can be used to incapacitate or kill enemy troops through disease. They can cause large numbers of casualties and can force the enemy to use large numbers of personnel and vast quantities of supplies to treat the casualties.

*b. Antianimal Biological Agents.* Antianimal agents can be used to injure or kill domestic food and draft animals through disease. They can curtail the enemy

food supply, animal transportation facilities, and such byproducts as hides, wool, fats, and biological medicinal products.

*c. Anticrop Agents.* Anticrop agents can be used to damage or destroy food or industrial crops. They can reduce crop yields and thus impair the enemy's war effort. However, these effects are very slowly achieved.

### 99. Characteristics of Biological Agents

Biological agents differ among themselves in the effects they produce on humans, animals, and plants. The capabilities, characteristics, and limitations of each biological agent must be recognized and carefully evaluated before the agent can be used to the greatest advantage in tactical operations. Some of the basic characteristics of antipersonnel biological agents listed below apply, with modifications, to most biological agents.

*a. Large-Area Coverage.* Biological agents can cover large areas with relatively small munition expenditures.

*b. Difficulty of Detection.* Biological agents produce no immediate physiological reaction nor can they be detected by the physical senses.

*c. Flexibility.* Biological agents can be selected to produce death or varying degrees of incapacitation among target personnel.

*d. Delayed Casualty Effect.* The employment of biological agents can be coordinated with planned future operations by consideration of the incubation or "lag" period characteristics of each agent selected.

*e. No Materiel Damage.* Biological agents affect only living things; they have no effect on materiel.

## 100. Effects of Weather

Biological agent cloud travel is affected by meteorological conditions in the same general manner as chemical agent cloud travel is affected (pars. 20–22). However, the following meteorological conditions have specific application to biological agent cloud travel and employment:

*a. Wind Speed.* Biological agents with a high decay rate can be employed effectively at high wind speeds (9 to 18 knots). At these wind speeds, biological agents are exposed to adverse environmental conditions for a shorter time, and greater area coverage can be obtained during the decay period.

*b. Sunlight.* Exposure to sunlight will increase the decay rate of a biological agent aerosol, thereby reducing its area coverage. For this reason, in addition to the existence of an unfavorable temperature gradient on sunny days, the preferable time for a biological attack is at night.

*c. Relative Humidity.* Aerosols of wet biological agents have a high decay rate during periods of low relative humidity because of increased evaporation of the moisture within the cell.

## 101. Effects of Terrain

Biological agent cloud travel is affected by terrain characteristics in the same general manner as chemical agent cloud travel is affected (pars. 25–28). Ground contamination following a biological aerosol attack is not generally considered a hazard to troops crossing or occupying the terrain because of the short life of viable agents.

## 102. Methods of Delivery

Biological agents may be delivered to enemy targets by the following methods:

*a. Rockets.* Biological warheads may be delivered to enemy areas by rockets.

*b. Guided Missiles.* Biological warheads may be delivered deep into enemy areas by guided missiles.

*c. Aircraft.* Aircraft can deliver biological agents deep into enemy areas by bombs or special disseminators.

*d. Vectors.* Vectors (insects and insectlike organisms) may be delivered to the target area by rockets, guided missiles, or aircraft. By their natural means of locomotion, vectors may then disseminate biological agents to target personnel.

## 103. Techniques of Biological Attack

The two general methods of attacking a target with biological agents are described below. Biological agents can be disseminated as aerosols to infect man by inhalation or disseminated by vectors to infect man through the skin. Vectors can circumvent the protection given by the wearing of a mask against aerosols and can maintain the agents in an area longer than aerosols can.

*a. On-Target Attack.* Biological agents are disseminated directly over the target area. This method of attack provides the maximum degree of operational control. Since the agent is distributed somewhat uniformly over the target area, wind direction and speed are not considered to be critical factors.

*b. Off-Target Attack.* Biological agents are disseminated at a substantial distance upwind of the target area. The agent, once released, is transported over the target area by the wind.

## Section II. EMPLOYMENT OF ANTIPERSONNEL BIOLOGICAL AGENTS

### 104. General

Antipersonnel biological agents may be used tactically to assist the field commander in accomplishing his mission. Biological attacks are particularly effective in the preparatory phase of a large-scale coordinated attack. They are also effective in any campaign where it is necessary to bring every possible means of attrition to bear on enemy forces. For example, in the defensive-offensive type campaign where the enemy initially has a superiority in manpower, biological attacks can assist the commander so that the tactical situation prevailing at the resumption of the offensive will favor friendly forces. The choice of the biological agent to be used against enemy personnel depends on the mission and objective of the commander, his plan of operations, the effects desired, the availability of the agent and the munitions, and the susceptibility of the target population. The employment of biological agents requires staff consideration of the capabilities of available weapons for delivering the agent, the munition requirements, and friendly troop and civilian safety.

### 105. Capabilities

Antipersonnel biological agents can be selected to produce lethal or incapacitated casualties in combat

areas or enemy rear areas. Lethal agents may be employed to reduce enemy numerical strength. Incapacitating agents may be employed to produce casualties who require large amounts of medical supplies, extensive facilities for treatment, and many personnel to treat them, thereby impeding enemy military operations.

### 106. Tactical Objectives

Plans for the employment of biological agents are integrated into the field army scheme of maneuver. Possible tactical objectives for the employment of biological agents are to—

*a. Soften Enemy Positions.* Biological agents can be used against strongly defended enemy positions to weaken them by producing casualties among defending enemy troops. Biological attacks must be made sufficiently in advance of the planned coordinated exploitation to allow for the incubation period of the disease.

*b. Hinder Support of Enemy Operations.* Biological agents can be used to produce casualties among enemy troops in reserve and in assembly areas. Biological attacks also affect personnel in enemy artillery and missile positions, observation posts, logistical installations, and communications facilities, thereby hindering support of enemy combat units.

### 107. Tactical Planning and Target Analysis

The commander's concept of operations forms the basis for biological target analysis. It provides guidance for determining the results desired, degree of risk acceptable for friendly troops, limitations and restrictions, and other related matters. Fundamental factors

that are considered when the employment of biological agents is planned and the sequence in which they are normally considered in the tactical operations center of a major command are—

*a. Selection of Targets.* The selection of targets for attack with biological agents requires coordination at field army level of reconnaissance, intelligence studies and reports, and staff evaluation of areas suspected of containing remunerative targets. Personnel targets that are vulnerable to or appropriate for biological attack are normally selected. Biological weapon systems can complement or supplement other weapon systems.

*b. Effects Desired.* Before a biological agent is selected for use against a designated target, the effects desired must be determined. The tactical situation may require lethal or incapacitating effects and a short- or a long-delayed casualty effect.

*c. Selection of Biological Agent.* The biological agent that can accomplish the effects desired is selected for employment against the designated target. Consideration is given to the aerosol decay rate of the agent, its casualty-producing capability, the susceptibility of target personnel, and the time required for the disease produced to reach useful casualty effectiveness. The following target characteristics are also considered:

(1) The quality and type of protection available to enemy personnel.
(2) The state of enemy biological defensive training and morale.
(3) The enemy biological attack warning system.

(4) Enemy biological agent detection and identification devices or systems.

(5) The weather and terrain of the target area.

*d. Influence of Target Characteristics on Agent Selection.* For general guidance in planning, the selection of a biological agent (having general characteristics as indicated below) for employment against tactical targets may be influenced by the following target characteristics:

| *Target characteristics* | *Agent characteristics* |
|---|---|
| (1) Primary enemy troops | Lethal or incapacitating |
| (2) High percentage of civilians | Incapacitating |
| (3) Close to friendly troops | High decay rate |
| (4) Large area | Low decay rate |

*e. Selection of Weapons and Munitions.* The weapon that can most effectively deliver the agent-munition to the target area is selected. In recommending the weapon system, consideration is given to the capabilities and availability of the biological munitions and the requirements for concealing the attack. Biological munitions are categorized according to methods of employment. The three basic methods of employment are: point source, multiple-point (area) source, and line source. Point-source munitions release the agent aerosol from a stationary point. The agent cloud is then dependent on the wind for target coverage. Multiple-point source munitions impact over a roughly circular area. Each single munition forms a single-point source aerosol cloud, which merges with nearby agent clouds to cover most of the target area. This type of employment is less dependent on wind speed and direction than are the other two types. Line-source munitions produce an aerosol in a line, either

from a stationary-point source or from a moving-point source.

*f. Influence of Target Characteristics on Munitions Employment.* For general guidance in planning, the selection of a method of employing biological munitions against tactical targets may be influenced by the following target characteristics:

| *Target characteristics* | *Method of employment* |
|---|---|
| (1) Small area | Point, multiple-point, or line source. |
| (2) Off-target attack preferred or required | Line or point source |
| (3) Wind direction predicted within 45° | Multiple-point or line source |
| (4) Large area | Multiple-point or line source |
| (5) On-target attack preferred or required | Multiple-point or line source |
| (6) Wind direction unpredictable | Multiple-point source |
| (7) Poor alert system | Point, multiple-point, or line source. |

## 108. Coordination

The employment of biological agents in current operations must be closely coordinated with planned future operations and with operations of adjacent friendly forces. A biological attack that may result in biological agents crossing unit boundaries downwind requires coordination with the unit affected and with the next higher command echelon. The employment of biological agents is normally coordinated at field army or independent corps but, in special situations, this responsibility may be delegated to lower echelons.

### 109. Offensive Operations

Biological agents are effective when employed to support offensive operations on relatively deep targets such as army and corps reserves when a delay in casualty production is acceptable. Enemy targets near the forward edge of the battle area (FEBA) are not attacked with biological agents when a delay in casualty production is not acceptable.

### 110. Defensive Operations

In defensive operations that are characterized by successive delaying positions, biological agents can be used against targets within close range of the FEBA. Biological casualties may not be produced in time to affect the defense of each delaying position, but casualties are produced eventually at some delaying position and, probably, by the time friendly forces initiate offensive operations. The length of time that a unit plans to defend a position influences the selection of targets against which biological agents can be employed.

### 111. Special Operations

The doctrine for the employment of biological agents in offensive and defensive operations applies generally to special operations. Some modification of this doctrine may be required in the following special operations because of meteorological or terrain conditions:

*a. Arctic.* The decay rate of biological agents is not as great in arctic areas as it is in tropical or temperate areas. Area coverage capabilities of biological munitions are increased and the need for refrigerated storage is reduced. Some factors that apply to chemical

operations in the arctic, such as decreased masking efficiency of troops, cloud behavior, and decreased munition efficiency, apply to biological operations as well.

*b. Jungle.* In jungle areas the prevailing wind speed is low and the average temperature is high. These chracteristics of jungle areas may reduce the area coverage capabilities and increase the expenditure requirements of aerosol-producing-type biological munitions.

*c. Island.* Enemy forces that are located on isolated islands are ideal targets for biological agents. Troop safety is no problem. In amphibious landings, biological attacks are made sufficiently in advance of the assault to allow time for the production of casualties. Biological attacks are made prior to the preparatory fires to assure surprise and prevent the enemy from being alerted.

*d. Counterguerrilla.* When enemy guerrilla forces are operating in mountainous, jungle, heavily forested, or sparsely settled areas, biological agents can be employed against them. When enemy guerrilla forces are operating in areas occupied by friendly civilians, incapacitating biological agents are used. Guerrilla forces normally do not have sufficient protective means, access to treatment facilities, or sufficient personnel to treat large numbers of casualties.

## 112. Troop Safety

The employment of biological agents may produce an area of hazard in which friendly troops are required to operate. There is little risk involved to friendly troops with normal protection and adequate warning.

However, the commander may be required to employ his troops in an area of hazard even though he is unable to warn all troops of the hazard. The command decision to accept a calculated risk is dependent upon the urgency of the tactical situation. The commander is advised of the probable effects of exposure to this hazard by the chemical officer and the medical officer. A degree of risk that can result in lethal casualties among friendly unwarned troops is unacceptable. The degree of risk that can result in incapacitated casualties among friendly unwarned troops must be kept so low that there will be no significant effect on the morale of friendly units in the path of the biological cloud travel. (See TC 3-7 for classified data about biological agents.)

*a. Command Decision.* The commander may decide the maximum degree of risk that he will accept as a downwind hazard to friendly troops, using the following criteria as a guide:

(1) *Negligible risk.* Biological aerosol hazard that may not require friendly troops to mask or to take any other precautions.

(2) *Moderate risk.* Biological agent hazard that may require friendly troops to mask for only a short period of time.

(3) *Emergency risk.* Biological agent hazard that requires friendly troops to mask for the duration of the biological cloud travel.

*b. Troop Safety Measures.* When an unacceptable risk to friendly troops can result from a biological attack against enemy forces, one or more of the fol-

lowing courses of action can be taken to protect friendly units:

(1) Use a biological agent-munition with a smaller radius of effect.

(2) Make the biological attack under less favorable meteorological conditions to reduce the area coverage.

(3) Withdraw friendly troops likely to be exposed.

(4) Insure that all friendly troops are warned of the biological attack and are required to remain masked for the time required for passage of the primary aerosol or for the time they are in the contaminated area.

# CHAPTER 7

# RADIOLOGICAL OPERATIONS

## 113. General

Nuclear weapons can be tactically employed to deliberately produce radioactive contamination. However, radioactive contamination can produce effects that significantly restrict the maneuver and operations of friendly troop units. Political implications of the effects of radioactive contamination are coordinated with the civil affairs staff officer (G5). (See FM 101–31 for doctrinal guidance.)

## 114. Characteristics of Radioactive Materials

Radioactive contamination can result from radioactive fallout, neutron-induced radioactivity from the detonation of a nuclear weapon, or the dissemination of radiological agents. These sources of contamination may emit one or more of the three types of nuclear radiation: alpha particles, beta particles, and gamma rays.

*a. Radioactive Fallout.* Radioactive fallout results from a surface or subsurface nuclear weapon explosion and consists of particles of soil and other materials that are contaminated with radioactive substances and have fallen to the earth. When employed deliberately

to deny the enemy use of an area, fallout is considered a radiological agent.

*b. Neutron-Induced Gamma Radioactivity.* Neutron-induced gamma radioactivity results from the reaction between many common nonradioactive materials (such as sodium, phosphorus, and silver) present in the soil and the neutrons released by a nuclear explosion.

*c. Radiological Agents.* Radiological agents are radioactive isotopes used deliberately to contaminate an area with the intent of producing casualties or denying use of the area to enemy personnel. To be effective, a radiological agent must emit gamma radiation which penetrates the body in the same manner as X-ray radiation.

### 115. Methods of Dissemination

The two basic methods for the dissemination of radioactive materials are—

*a. From a Nuclear Explosion.* A nuclear weapon can be deliberately detonated on or below the surface of a target area so that the resulting fallout contaminates the area with radioactive materials.

*b. Without a Nuclear Explosion.* Radiological agents can be delivered directly to a target area with no nuclear detonation involved. Potential delivery means include bombs, missile warheads, and drones.

### 116. Effects of Weather and Terrain

Meteorological conditions and the nature of the terrain are important factors in the radiological contamination effects of a nuclear burst.

*a. Weather.* Winds at various altitudes carry radioactive bomb residues and particles of contaminated soil to predictable distances, resulting in various patterns of ground coverage.

*b. Terrain.* Certain elements present in the soil under ground zero of a nuclear burst become radioactive for predictable and various periods of time.

### 117. Capabilities

Radioactive materials can be employed to restrict the use of an area to the enemy without destroying installations and material in the area. This restriction can be accomplished by the producing of casualties or through the threat of casualties from radioactivity among personnel who do not leave the area in a safe time. Radioactive materials can be employed to—

*a.* Contaminate an area of military interest to limit the activities of personnel remaining or to make evacuation of the area mandatory. Since radioactive contamination decays with time, reoccupation of the area by friendly forces should eventually be possible with little rehabilitation required of the installations in the area.

*b.* Contaminate a vital enemy installation that has been damaged by other weapons and thereby interfere with its reconstruction and repair. Radioactive materials can be used to disrupt and interfere with normal logistical activities in rear areas.

### 118. Troop Safety

Some of the troop safety matters that are considered in radiological operations include the following:

*a. Degrees of Risk.* The standard unit for measurement of radiation is the "rad." Command guidance on personnel exposure to radiation is given in chapter 11, section VI, FM 100–1. For deliberate exposure of friendly troops, the following interim degrees of risk may be used as a guide:

(1) Negligible risk—5 rads.
(2) Moderate risk—20 rads.
(3) Emergency risk—100 rads.

*b. Individual Protection.* The primary hazard associated with radioactive contamination is gamma radiation. Because of the penetrating nature of gamma radiation, complete protection is difficult to achieve when troops cross a contaminated area. However, some protection is afforded by the use of armored carriers or vehicles following preselected routes that permit a speedy and an uninterrupted crossing.

*c. Decay and Exposure Considerations.* The decay of radioactive materials can be predicted in accordance with physical laws. However, the average rate of decay varies with the source of the radiation. The rate of decay of gross fission products in normal radioactive fallout can be calculated by use of the tables, graphs, or nomograms contained in FM 101–31 and TC 101–1. The total dose charts and nomograms in these publications can be used to predict the amount of radiation received when troops operate in a contaminated area.

*d. Location of Contaminated Area.* An accurate prediction cannot be made of the location and dose rate of the radioactivity that results from fallout, principally because of the variability of the wind.

However, it is possible to predict a general area within which there is a high assurance that all militarily significant contamination will be contained. This prediction method is described in TC 101–1. Nevertheless, only through monitoring and survey is it possible to definitely locate the area of contamination.

*e. Command Responsibility.* Protection is obtained by limiting the time of exposure, by employing shielding, by avoiding contaminated areas, or by some combination of these measures. It is a command function to decide on the course of action, consistent with tactical requirements, that will accomplish the mission and at the same time result in the least exposure.

# APPENDIX I

## REFERENCES

| | |
|---|---|
| AR 220–50 | Regiments; General Provisions |
| AR 220–60 | Battalions, Battle Groups, Squadrons; General Provisions |
| AR 220–70 | Companies; General Provisions |
| AR 320–5 | Dictionary of United States Army Terms |
| AR 320–50 | Authorized Abbreviations and Brevity Codes |
| FM 3–50 | Chemical Smoke Generator Battalion and Chemical Smoke Generator Company |
| FM 6–20 | Field Artillery Tactics and Techniques |
| FM 6–40 | Field Artillery Cannon Gunnery |
| FM 19–15 | Civil Disturbances and Disasters |
| FM 20–32 | Land Mine Warfare |
| FM 20–33 | Ground Flame Warfare |
| FM 21–5 | Military Training |
| FM 21–6 | Techniques of Military Instruction |
| FM 21–30 | Military Symbols |
| FM 21–40 | Small Unit Procedures in Nuclear, Biological, and Chemical Warfare |

| | |
|---|---|
| FM 21–48 | Training Exercises and Integrated Training in Chemical, Biological, and Nuclear Warfare |
| FM 30–5 | Combat Intelligence |
| FM 30–7 | Combat Intelligence Battle Group, Combat Command, and Smaller Units |
| FM 30–16 | Technical Intelligence (U) |
| FM 31–21 | Guerrilla Warfare and Special Forces Operations |
| FM 31–25 | Desert Operations |
| FM 31–30 | Jungle Operations |
| FM 31–40 | Tactical Cover and Deception (U) |
| FM 31–50 | Combat in Fortified Areas and Towns |
| FM 31–60 | River-Crossing Operations |
| FM 31–71 | Northern Operations |
| FM 31–72 | Mountain Operations |
| FM 57–30 | Airborne Operations |
| FM 57–35 | Airmobile Operations |
| FM 60–5 | Amphibious Operations; Battalion in Assault Landings |
| FM 100–1 | Doctrinal Guidance (U) |
| FM 100–5 | Field Service Regulations; Operations |
| FM 101–5 | Staff Officers' Field Manual: Staff Organization and Procedure |
| FM 101–31 | Staff Officers' Field Manual: Nuclear Weapons Employment (U) |
| TM 3–200 | Employment of Toxic Chemical Agents |
| TM 3–200A | Employment of Toxic Chemical Agents (U) |

| | |
|---|---|
| TM 3–215 | Military Chemistry and Chemical Agents |
| TM 3–216 | Military Biology and Biological Warfare Agents |
| TM 3–240 | Field Behavior of Chemical Agents |
| TM 3–366 | Flamethrower and Fire Bomb Fuels |
| TC 3–7 | Capabilities and Employment of Biological Agents (U) |
| TC 3–9 | Use of Agent CS in Training and Riot Control |
| TC 3–10 | Defense Against V-Agents |
| TC 101–1 | Prediction of Fallout and Radiological Monitoring and Survey |
| TC 101–2 | Tactical Operations Centers |
| TC 101–3 | Nuclear Radiation Terminology |
| DA Pam 108–1 | Index of Army Motion Pictures, Film Strips, Slides, and Phono-Recordings |
| DA Pam 310–1 | Index of Administrative Publications |
| DA Pam 310–3 | Index of Training Publications |
| DA Pam 310–4 | Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders |
| DA Pam 310–5 | Index of Graphic Training Aids and Devices |
| DA Pam 310–7 | Index of Tables of Organization and Equipment, Type Tables of Distribution, and Tables of Allowances |

# APPENDIX II

# CHEMICAL SMOKE AMMUNITION REQUIREMENTS

## 1. General

Smoke ammunition expenditure tables have been determined for various weapons under a variety of weather and terrain conditions. The ammunition expenditure tables for artillery weapons in this appendix are useful as a *guide only*. Expenditures needed in actual smoke operations vary considerably with each specific mission. The amount of smoke ammunition required to maintain the smoke screen must be determined by observation rather than by the figures given in any table. Trained observers are needed to adjust a large-scale smoke screen to the target, to alter the smoke screen to fit changing conditions, to keep the screen free of holes and gaps, and to increase or decrease the expenditure of smoke ammunition when necessary.

## 2. Smoke Ammunition Expenditures

The smoke ammunition expenditure tables III through V give the approximate number of rounds per minute required to maintain a smoke curtain on a 500-meter front. Under normal conditions, about 3 minutes are required to adjust fire on the target and

about 1 minute is required to establish the smoke curtain.

*a. Smoke Curtain.* A smoke curtain is established by employing volley fire, using twice the amount of ammunition during the first minute as is required to maintain the smoke curtain per minute.

*b. Blinding Smoke.* It takes approximately twice as many rounds of smoke ammunition per minute to produce a blinding smoke effect on a 500-meter front as it does to maintain a smoke curtain.

### 3. Unit Capabilities

Unit capabilities to establish and maintain a smoke curtain or a smoke screen vary widely with the existing meteorological conditions in the target area. The size of an area over which a unit is capable of establishing and maintaining a smoke curtain can be determined by the use of two factors: the unit capability to deliver smoke rounds to the target (rate of fire) and the ammunition requirements for a 500-meter front (tables III through V). For example, a mortar platoon of six 4.2-inch mortars can effectively screen an average front of about 1,000 meters; under favorable conditions it can screen three times its average front; under unfavorable conditions it may be able to screen only one-eighth of its average front. (See TM 3–200 for a table of rates of fire for artillery weapons.)

### 4. Use of Tables

Smoke ammunition expenditure tables III through V have been calculated on the basis of meters and hectares (an area equal to a 100-meter square). Data in the ammunition expenditure tables may be considered optimum for the stated conditions. The tables indicate

the number of rounds that must impact in the target area; no allowance has been made for extra shell which, because of dispersion characteristics of the weapon, are needed to insure that the required number fall on the target. Any margin needed for this purpose is the responsibility of the commander of the firing unit, since dispersion varies with each type of weapon and increases with range.

*Table III. Smoke Ammunition Requirements for 105-mm Howitzers*

| SMOKE CURTAIN | | | |
|---|---|---|---|
| Number of rounds per minute required to maintain a smoke curtain on a 500-meter front [1] | | | |
| WIND DIRECTION | | | |
| Following (6 o'clock) | Head (12 o'clock) | Flank (3 or 9 o'clock) | Quartering |
| 22 | 22 | 8 | 17 |
| BLINDING SMOKE EFFECT | | | |
| Number of rounds per minute required to maintain a blinding smoke effect on a 500-meter front | | | |
| 50 | 39 | 8 | 33 |

| SMOKE CURTAIN USING BASE EJECTION SHELL[2] | | | | |
|---|---|---|---|---|
| Maximum meters between points of shell impact (parallel to front) | | Rate of fire per point of impact (rounds per minute) | | |
| WIND DIRECTION | | WIND SPEED | | |
| 6 and 12 o'clock | 3 and 9 o'clock | 3 knots | 9 knots | 13 knots |
| 27 | 360 | 1.0 | 1.5 | 2.0 |

[1] To establish a smoke curtain, employ volley fire, using 2-minute ammunition requirement. Equally space rounds on the front to be curtained.

[2] To establish the initial curtain, fire two rounds per point of impact as quickly as possible; to maintain the curtain after that, fire at the rate indicated.

## *Table IV. Smoke Ammunition Requirements for 4.2-Inch Mortars*

### A. SMOKE CURTAIN

Number of rounds per minute required to maintain a smoke curtain on a 500-meter front in flank winds [1 2 3]

| Relative humidity (percent) | Temperature gradient [4] | WP-filled | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Wind speed (knots) [5] | | | | | | |
| | | 2 | 4 | 9 | 13 | 18 | 22 | 26 |
| 30 | LAPSE | 13 | 13 | 11 | 11 | 13 | | |
| | NEUTRAL | 9 | 9 | 7 | 7 | 9 | 9 | 11 |
| | INVERSION | 6 | 6 | 4 | | | | |
| 60 | LAPSE | 9 | 9 | 7 | 9 | 9 | | |
| | NEUTRAL | 6 | 6 | 4 | 4 | 6 | 7 | 9 |
| | INVERSION | 3 | 3 | 3 | | | | |
| 90 | LAPSE | 7 | 7 | 6 | 6 | 7 | | |
| | NEUTRAL | 4 | 4 | 3 | 3 | 4 | 6 | 6 |
| | INVERSION | 3 | 3 | 3 | | | | |

## B. BLINDING SMOKE EFFECT

The number of rounds per minute required to maintain blinding smoke effect on a 500-meter front is obtained by doubling the values in A above.

[1] To establish a smoke curtain, employ volley fire, using 2-minute ammunition requirement (but not less than 10 rounds). Equally space rounds on the front to be curtained.

[2] For quartering winds, multiply table values by 2; for head (12 o'clock) winds, by 2; for following (6 o'clock) winds, by 2½. Values for quartering and following winds are based on curtain impact line of 500 meters in advance of enemy line. If curtain impact line is closer than 500 meters, ammunition requirements will be considerably greater. CONTROLLED FIRE BY OBSERVERS IS NECESSARY AT ALL TIMES.

[3] Table quantities are for shell impacted on land. For water impacts, multiply table values by 1.4.

[4] See paragraph 21 for an explanation of temperature gradients.

[5] To convert knots to miles per hour, see appendix III for conversion factor.

*Table V. Smoke Ammunition Requirements for 155-mm Howitzers and Guns*

## SMOKE CURTAIN

Number of rounds per minute required to maintain a smoke curtain on a 500-meter front [1]

### WIND DIRECTION

| Following (6 o'clock) | Head (12 o'clock) | Flank (3 or 9 o'clock) | Quartering |
|---|---|---|---|
| 7 | 7 | 3 | 6 |

## BLINDING SMOKE EFFECT

Number of rounds per minute required to maintain a blinding smoke effect on a 500-meter front

| | | | |
|---|---|---|---|
| 17 | 11 | 3 | 11 |

## SMOKE CURTAIN USING BASE EJECTION SHELL[2]

| Maximum meters between points of shell impact (parallel to front) | | Rate of fire per point of impact (rounds per minute) | | |
|---|---|---|---|---|
| WIND DIRECTION | | WIND SPEED | | |
| 6 and 12 o'clock | 3 and 9 o'clock | 3 knots | 9 knots | 13 knots |
| 27 | 360 | 0.6 | 0.9 | 1.2 |

[1] To establish a smoke curtain, employ volley fire, using 2-minute ammunition requirement. Equally space rounds on the front to be curtained.

[2] To establish the initial curtain, fire two rounds per point of impact as quickly as possible; to maintain the curtain after that, fire at the rate indicated.

# APPENDIX III

## CONVERSION FACTORS

*Conversion factors that are useful for quick reference*

| | |
|---|---|
| 1 meter | 39.4 inches |
| 1 meter | 1.1 yards |
| 1 kilometer | 0.6 mile |
| 1 mile | 1.6 kilometers |
| 1 knot | 1.15 miles per hour |
| 1 square yard | 0.8 square meter |
| 1 hectare | 10,000 square meters |
| 1 hectare | 11,960 square yards |
| 1 square mile | 259 hectares |
| 1 milligram | 1/1,000 of 1 gram |
| 1 ounce | 28.35 grams |
| 1 pound | 453.6 grams |
| Degrees Fahrenheit | 9/5° C. + 32° |
| Degrees Centigrade | 5/9 (°F. — 32°) |

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For explanation of abbreviations used, see AR 320-50.

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